Saint-Laurent
Vision 2000

The SLV 2000 Action Plan, Phase III
A Unique Contribution to Sustainable Development
A Socioeconomic Cost/Benefit Assessment

Canada

Québec

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The SLV 2000 Action Plan, Phase III: A Unique Contribution to Sustainable Development A Socioeconomic Cost/Benefit Assessment

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SUMMARY

The St. Lawrence Vision 2000 Action Plan (SLV 2000) (1998-2003) is the result of an ongoing process of co-operation between a number of government partners. Since 1988, we have had to deal with a number of new issues and new partners have been added to the initial core group, showing how much interest there is in this initiative all along the St. Lawrence River and around the Gulf. This paper is a report on a socio-economic assessment of the main results of Phase III against a backdrop of sustainable development (economic, social and environmental), following on from the two previous phases.

The approach taken in this study is the "total capital" approach, which, while using the classical cost/benefit analysis model, also allows for contributions to the various types of capital to be taken into account: financial capital, man-made capital, natural capital and human and social capital. The distinguishing feature of the SLV 2000 Action Plan, then, is the diversity of its spin-offs.

In general, and however conservatively we estimate, it is clear that the investment in Phase III of SLV 2000 is justified, as the average ratio of benefits to discounted costs for the 1998-2003 period is on the order of 1.41 (at 5%) and 1.39 (at 10%). Moreover, if the benefits were tracked over twenty years, the ratio would be still more favourable to the continuation of the efforts of Phase III.

To be more precise, the following are the main observations to be made regarding the various forms of capital:

Financial capital
The increase in financial capital attributable to SLV 2000 is measured by ripple effects and by the financial and economic spin-offs generated by the Plan:

- As regards ripple effects, expenses for this phase were on the order of $256 million, including some $30 million in new money (SLV 2000), the rest being regular program funding. The ripple effect of this new money from the standpoint of resources mobilized within regular programs is one SLV dollar to nine regular program dollars. This shows the keen interest in protection, conservation and enhancement of the St. Lawrence among all SLV 2000 partners.
- SLV 2000 leverages both non-governmental expenditures (close to $1 million over five years) and environmental expenditures in support of local projects (more than $10 million over five years); and this is quite apart from the specific effects on the agricultural sector, which are estimated at more than $2 million.
- SLV 2000 has also facilitated large companies' commitment to environmental clean-up; their contributions may reach 8 to 10 million dollars.

All told, the financial leverage is close to $24 million over five years.

- Economic spin-offs, finally, amount to $218 million. Their effect is to increase gross domestic product (GDP), including a contribution of about $43 million in tax and quasi-tax revenue, in

addition to the maintenance or creation of 3,719 jobs over the 1998-2003 period. These spin-offs are a measure of the impact of Action Plan spending on the Quebec economy, a very significant one considering how little new money was invested.

Man-made capital

Infrastructure that could contribute to sustainable development and which is, in whole or in part, directly or indirectly, attributable to Phase III of SLV 2000 is as follows:

- Development, at a number of riverside locations, of reception, parking and picnic areas, as well as river access points. The monetary value of these developments can certainly be set at some $1.7 million a year.
- Assistance to farmers in six regions, several of which are along the St. Lawrence, to install waterproof livestock manure storage facilities. The value of these benefits, based on willingness to pay, is estimated at some $22 million a year.
- The reopening of the Lachine Canal to recreational boating after contamination sources were identified and decontamination options selected (Phases I and II) and an assessment was made as to whether potentially contaminated sediments could go back into suspension. The use value of this canal was not considered in estimating the benefits of Phase III of the Plan, although its opening is already seen as promising.

In all, therefore, the value of man-made capital should total at least $119 million over five years.

Natural capital

With respect to the development of natural capital, the following effects were noted:

- Gradual improvement in water quality and fish health, so that fishing can continue on the St. Lawrence. It has not been possible to quantify the use value of the increase in sport fishing due to improved water quality and fish health. However, we do know that more than two million people take part in outdoor activities within the St. Lawrence watershed; close to 800,000 people participate in sport fishing, and some 835,000 in swimming or beach activities. The St. Lawrence and its tributaries therefore remains a strategic territory for maintenance of these activities.
- An improvement in the condition of the St. Lawrence, which has helped maintain the waterfowl population, although this benefit cannot be quantified for want of data.
- Reduction of the speed of commercial shipping on the portion of the St. Lawrence deemed most sensitive, which has resulted in reduced shoreline erosion. The value of this, based on the cost of development of a stable shoreline (replacement with an artificial barrier), is some $50 million.
- Clean-up, restoration and replanting with native vegetation of the shores of the St. Lawrence and some of its tributaries, as well as the protection, conservation and enhancement of habitat and wetlands. The value of shoreline improvement work is about $18.7 million a year.
- Protection of 107,000 ha of land based on the value of a single ecological function, which may total $15.2 million a year.

- Construction of a fish ladder (at St. Ours) that is unique in the world in that it accommodates five different species at once. This technical innovation is now being exported to a number of foreign countries. The benefit derived from visits of this infrastructure is around $232,000 a year.

In all, the estimated value of the financial benefits, in the light of natural capital, is on the order of $221 million over five years.

Human and social capital

The development of human and social capital may take different forms:

- A considerable amount of volunteer work, totalling more than 466,000 hours in the various activities, and particularly those of the ZIP Program (Area of Prime Concern), special projects being conducted under the Community Interaction Program and through the Biosphere's Ecowatch Network (BEN). The value of this volunteer work is estimated at more than $650,000 a year on the basis of a low opportunity cost (Quebec minimum wage).
- Consolidation of the joint action of the various committees, in particular the Navigation Committee, which includes private partners and non-governmental organizations (NGOs), and improved co-ordination of the actions of the various stakeholders.
- Frequent use of new ways of disseminating information on the state of the St. Lawrence, such as the bulletin *Le Fleuve* and the SLV 2000 website, in addition to a wide range of media-aware communications. The opportunity cost of looking up information on the website, again related to the Quebec minimum wage, is about $490,000.
- Facilitation of exchanges between municipalities and industry on the assessment and measurement of toxic discharges. New models for action are under development.
- Establishment of sustained co-operation between the various departments of both levels of government with respect to environmental monitoring of the St. Lawrence: a first.
- Launch or completion of applied research on the St. Lawrence with a view to acquiring knowledge, in particular, about issues such as water levels, and supporting decision-making in the area of human health, a subject of concern to the vast majority of riverside residents.

Although it is limited by the data available, a rough estimate of the value of this human and social capital puts it at more than $5.7 million over five years, which is clearly a floor, not a ceiling, since many aspects of it cannot be assigned a monetary value.

RÉSUMÉ

Le Plan d'action Saint-Laurent Vision 2000 (SLV 2000) (1998-2003) est le fruit d'une collaboration continue entre plusieurs partenaires gouvernementaux. Depuis 1988, on a dû faire face à plusieurs nouveaux enjeux et de nouveaux partenaires se sont ajoutés au noyau de départ, montrant l'intérêt de cette initiative à l'échelle du Saint-Laurent fluvial et marin. Le présent document rapporte une évaluation socioéconomique des principaux résultats de la phase III dans un contexte de développement durable (économique, social et environnemental) et en continuité avec les deux phases précédentes.

L'approche retenue dans l'étude est celle du capital total qui, tout en utilisant le modèle classique de l'analyse avantages-coûts, permet de tenir compte des contributions aux différents types de capitaux que sont le capital financier, le capital construit, le capital naturel et le capital social ou humain. Ce qui caractérise le Plan d'action SLV 2000, c'est donc la diversité de ses retombées dans le milieu.

De manière générale et tout en restant conservateurs dans nos estimations, nous constatons que l'investissement de la phase III de SLV 2000 est justifié; le ratio moyen des avantages aux coûts actualisés à 5 % étant de l'ordre de 1,41 sur la période 1998-2003 et 1,39 à 10 %. Si l'on tenait compte des avantages sur vingt ans, par exemple, le rapport serait encore plus favorable à la poursuite des efforts de la phase III.

De manière plus précise, voici les principaux constats que l'on peut faire relativement aux différentes formes que prend le capital :

Le capital financier
L'accroissement du capital financier attribuable à SLV 2000 est mesuré par les effets d'entraînement et par les retombées économiques financières qu'a générés le Plan :

- Au regard des effets d'entraînement, les dépenses liées à cette phase ont été de l'ordre de 256 millions de dollars, dont environ 30 millions d'argent neuf (SLV 2000), le reste provenant d'argent de programmes réguliers. L'effet d'entraînement de ce nouvel argent du point de vue des ressources mobilisées au sein des programmes réguliers se traduit par un rapport de un (dollar SLV) pour 9 (dollars de programmes réguliers), témoignant ainsi de l'intérêt que suscitent la protection, la conservation et la mise en valeur du Saint-Laurent chez l'ensemble des partenaires de SLV 2000.
- SLV 2000 a un effet de levier à la fois sur des dépenses extragouvernementales (près de un million de dollars sur cinq ans) et sur les dépenses du milieu soutenant des projets locaux (plus de 10 millions de dollars sur cinq ans), sans compter l'effet spécifique sur le milieu agricole estimé à plus de deux millions de dollars.
- SLV 2000 a aussi facilité l'engagement de grandes entreprises à la décontamination du milieu pour une contribution pouvant atteindre de 8 à 10 millions de dollars.

L'ensemble des effets de levier sur le plan financier s'élèvent à près de 24 millions de dollars sur cinq ans.

- Enfin, en ce qui concerne les retombées économiques, elles se chiffrent à 218 millions de dollars. Ces retombées se traduisent par une augmentation du produit intérieur brut (PIB), dont une contribution d'environ 43 millions de dollars de recettes fiscales et parafiscales, en plus du maintien ou de la création de 3 719 emplois au cours de la période 1998-2003. Ces retombées mesurent l'impact des dépenses du Plan d'action sur l'économie québécoise, un impact fort appréciable si l'on tient compte du fait que peu d'argent neuf a été investi.

Le capital construit

Les infrastructures susceptibles de contribuer au développement durable et qui sont directement, indirectement, en partie ou en totalité attribuables à la phase III de SLV 2000 sont les suivants :

- L'aménagement, dans plusieurs localités riveraines, d'aires d'accueil, d'espaces de stationnement et de pique-nique ainsi que d'accès au fleuve. La valeur financière de cette intervention peut certainement être estimée à environ 1,7 million de dollars annuellement.
- L'aide aux agriculteurs de six régions dont plusieurs situées en bordure du Saint-Laurent pour se doter de structures d'entreposage étanches servant à confiner les déjections animales. La valeur des avantages basée sur le consentement à payer est estimée à quelque 22 millions de dollars par année.
- La réouverture du canal Lachine à la navigation de plaisance après l'identification des sources de contamination et la rétention des options de décontamination (phases I et II) ainsi que l'évaluation de la remise en suspension des sédiments potentiellement contaminés. La valeur d'usage de ce canal n'a pas été considérée dans l'estimation des avantages de la phase III du Plan, bien que l'ouverture s'avère déjà prometteuse.

Au total, donc, la valeur du capital construit s'élèverait à au moins 119 millions sur cinq ans.

Le capital naturel

En ce qui a trait au développement du capital naturel, on note les effets suivants :

- L'amélioration graduelle de la qualité de l'eau et de l'état de santé des poissons, qui permet de maintenir l'usage de pêche dans le Saint-Laurent. La valeur d'usage attribuable à l'accroissement de la pêche sportive en raison de l'amélioration de la qualité de l'eau et de l'état de santé des poissons n'a pu être considérée. Toutefois, on sait que plus de deux millions de personnes participent à des activités de plein air en lien avec le bassin du Saint-Laurent ; près de 800 000 personnes pratiquent aussi la pêche récréative et 835 000 des activités de natation ou de plage. Le Saint-Laurent et ses affluents demeurent donc un territoire stratégique pour le maintien de ces activités.
- L'amélioration de l'état du Saint-Laurent, qui a favorisé le maintien de la population de sauvagine, bien que l'on ne puisse évaluer cet avantage faute de données.
- La réduction de la vitesse des navires commerciaux sur la portion jugée la plus sensible du Saint-Laurent, ce qui a permis une réduction du recul de la rive. La valeur de cette intervention basée sur le coût de remplacement (artificialisation) d'une rive naturelle par une barrière artificielle est de l'ordre de 50 millions de dollars.

- Le nettoyage, la restauration et la revégétalisation des rives du Saint-Laurent et de certains tributaires, ainsi que la protection, la conservation et la mise en valeur d'habitats et de milieux humides. La valeur des travaux d'amélioration des rives est de l'ordre de 18,7 millions de dollars par année.
- La protection de 107 000 hectares de terrains basée sur la valeur d'une seule fonction écologique, qui peut totaliser 15,2 millions de dollars par année.
- L'aménagement d'une passe migratoire (à Saint-Ours) unique au monde en ce sens qu'elle est commune à cinq espèces différentes et constitue une innovation technique en voie d'être exportée dans plusieurs pays étrangers. Les avantages conférés par la fréquentation de cette infrastructure sont de l'ordre de 232 000 $ par année.

Au total, la valeur estimée des avantages financiers et considérés relativement au capital naturel est de l'ordre de 221 millions de dollars sur cinq ans.

Le capital humain et social

Le développement du capital humain et social prend différents aspects :

- Un important bénévolat, qui totalise plus de 466 000 heures dans les diverses activités et particulièrement celles du programme ZIP (Zones d'intervention prioritaire), des projets particuliers réalisés dans le cadre du programme Interactions communautaires et du Réseau ObservAction de la Biosphère (ROAB). La valeur de ce bénévolat est estimée à plus de 650 000 $ par année, sur la base d'un faible coût d'opportunité (salaire minimum du Québec).
- La consolidation de la concertation des divers comités, notamment du Comité Navigation qui réunit des partenaires privés et des organismes non gouvernementaux (ONG), et l'amélioration de la coordination des actions des divers intervenants.
- L'utilisation fréquente de nouveaux modes de diffusion d'information sur l'état du Saint-Laurent, soit le bulletin *Le fleuve* et le site Web de SLV 2000, en plus d'un large éventail d'interventions de communication médiatisées. Le coût d'opportunité de la consultation de l'information sur le site Web, toujours en fonction du taux du salaire minimum du Québec, s'élève à environ 490 000 $.
- La facilitation des échanges entre les municipalités et les industries pour l'évaluation et la mesure des rejets toxiques. De nouveaux modèles d'intervention sont d'ailleurs en élaboration.
- L'établissement d'une collaboration soutenue entre divers ministères des deux paliers de gouvernement en matière de suivi environnemental du Saint-Laurent, une première.
- Le lancement ou l'achèvement de recherches appliquées sur le Saint-Laurent qui favorisent l'acquisition de connaissances, notamment face à des enjeux comme les niveaux d'eau, et appuyant la prise de décision en matière de santé humaine, un sujet de préoccupation pour une vaste majorité des riverains.

Bien qu'elle soit limitée par les données disponibles, l'estimation de la valeur du capital humain et social situe celle-ci à plus de 5,7 millions de dollars sur cinq ans, une borne inférieure compte tenu que plusieurs éléments de cette rubrique ne peuvent être évalués monétairement.

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1 CONTEXT OF ST. LAWRENCE VISION 2000, PHASE III

In June 1998, Phase III of the St. Lawrence Action Plan began with the signature, by the federal Department of the Environment, the Quebec department of the environment and wildlife (MEF) and the Quebec department of Canadian intergovernmental affairs, of a new five-year co-operation agreement. This agreement has three main objectives: protection of the health of the ecosystem, protection of human health and involvement of the riverside community. Note: 37 outcomes were targeted, for a planned budget envelope of $239 million.

The federal and Quebec government departments, organizations and agencies that have pooled their expertise, information and resources are: on the one hand, Agriculture and Agri-Food Canada, Canada Economic Development, Environment Canada, Parks Canada, Fisheries and Oceans Canada, Health Canada, Transport Canada and Public Works and Government Services Canada and, on the other hand, the Quebec departments of the environment, agriculture, fisheries and food, health and social services, and transportation, as well as the *Société de la faune et des parcs du Québec* [Quebec wildlife and parks corporation].

Phases I and II were chiefly concerned with urgent action, for instance to control pollution sources and protect critical habitats. Phase III carries on the efforts of the past ten years, in particular in the fields of reduction of industrial and agricultural pollution, protection and conservation of biodiversity, and acquisition and dissemination of knowledge about the health of people living along the St. Lawrence. In addition, two new fields of study related to shipping and the impact of water level variations are looking at major issues for the sustainable development of the St. Lawrence. It should be noted, also, that community involvement has taken on an even more importance in Phase III.

In November 2000, the co-chairs of St. Lawrence Vision 2000 (SLV 2000) asked for a socioeconomic review to be done of the effort put into Phase III of SLV 2000 as well as its marginal benefits. This is that review, which seeks to assess the direct and indirect spin-offs, both economic and social, of the entire SLV 2000 program.

The study covers all SLV 2000 components and all activities of the departments concerned at both levels of government. These are the components:

- Community Involvement;
- Human Health;
- Biodiversity;
- Navigation;
- Industrial and Urban;
- Agriculture;
- Communications.

As the study is being done on the basis of data compiled up to September 2002 and the plan extends to 2003, extrapolations are made based on anticipated results for March 2003 when information is considered adequate. A link is made to the first two phases of the St. Lawrence Action Plan when it is possible and relevant to do so.

The main point of this exercise is spin-offs, whether these take the form of money, new infrastructure, ecological impacts or social contributions. The idea is not to do an administrative assessment of the achievement of the planned results, as that will be covered by another exercise. In other words, the emphasis is on the results of

SLV 2000 Phase III and not on the effectiveness of the management process by which those results were achieved.

It should be noted that various different assessment concepts and methods are used throughout this evaluation. To avoid cluttering the text but facilitate the reader's understanding, a glossary is included in Appendix 1. Similarly, endnotes have been placed at the end of the paper.

2 EVALUATION APPROACH AND METHODOLOGY

2.1 Extension of cost/benefit analysis[1] to the total capital approach

Cost/benefit analysis has long been recognized as a suitable assessment framework for major projects and for policies and programs. This was true, in particular, of the USA under the Reagan administration and for administrative decisions from the early 1980s that obliged the Environmental Protection Agency (EPA) to assess the costs and benefits of its main regulatory activities.[2] In Canada, Treasury Board, for its part, has since 1974 had a major project evaluation guide, which provides guidance in evaluating projects conducted in Canada using federal funding. Since then, there have been a number of developments, both from the standpoint of approach and with respect to evaluation tools; for example, contingent valuation is useful in valuing certain less tangible goods and services.[3] More recently, in 1995, Treasury Board revised its guide to the evaluation of costs and benefits and updated its approach in 1998 (draft, Treasury Board Secretariat), while establishments such as Hautes Études Commerciales recognized the need to make the new generation of managers more aware of the strengths and weaknesses of this type of analysis in practice (Gauthier and Thibault, 1993).

As is recognized by the authors Mishan, Pearce, Lind, Haveman and numerous others, cost/benefit analysis continues to provide a general reference framework whereby a project's various benefits and drawbacks, in time and in space, can be compared using a common (ideally financial) format. This framework is certainly useful, but provides little information on the link between tangible values (set by clearly-structured markets) and those that are less so (values set by imperfect markets or non-market values such as air or water).[4] As by virtue of its overall objectives, SLV 2000 Phase III is concerned with benefits or issues of an intangible nature, the approach should reflect this—without however negating the basic economic rationality underpinning this assessment.

For that reason, the approach taken for this socioeconomic assessment is inspired by the notion of *total capital*. This approach, originated by the World Bank in the late 1990s, is beginning to be recognized as one of the most relevant for achieving sustainability of development and its various defining aspects, such as addition to growth; it emphasizes the qualitative element. In Canada, the National Round Table on the Environment and the Economy (NRTEE) adopted this framework in order to develop new sustainability indicators (Smith, Simard and Sharpe, 2001). The NRTEE uses it experimentally to develop an accounting system for water specifically, which is however limited to "natural" capital (Environmental Economics Branch, 2001).

In Quebec, the *Institut national de santé publique* [Quebec public health institute] recently drew on this approach to give a definition to social and community development (*Institut national de santé publique*, 2002).

The "total capital" approach allows variables useful in cost/benefit analysis to be coherently interrelated while the special features of the various forms of "capital" are also considered. Let us recall that "capital" means all inputs to an economic production process or to the process of creation or accumulation of the wealth of a nation.

If we are emphasizing the notion of wealth with sustainability, we cannot restrict the meaning of "capital" to the financial dimension only. For that reason, the total capital approach requires consideration to be given to all forms of available capital that can improve the productivity and quality of life of a given population or community.

To be precise, this means: financial capital, man-made capital, natural capital, human and social capital (terms defined in Appendix 1; see also Figure 1)—various interdependent forms of wealth.

However, economists have long recognized various forms of capital as part of the economic system (think of the classic separation into capital, labour and land proposed by 19th-century economists).

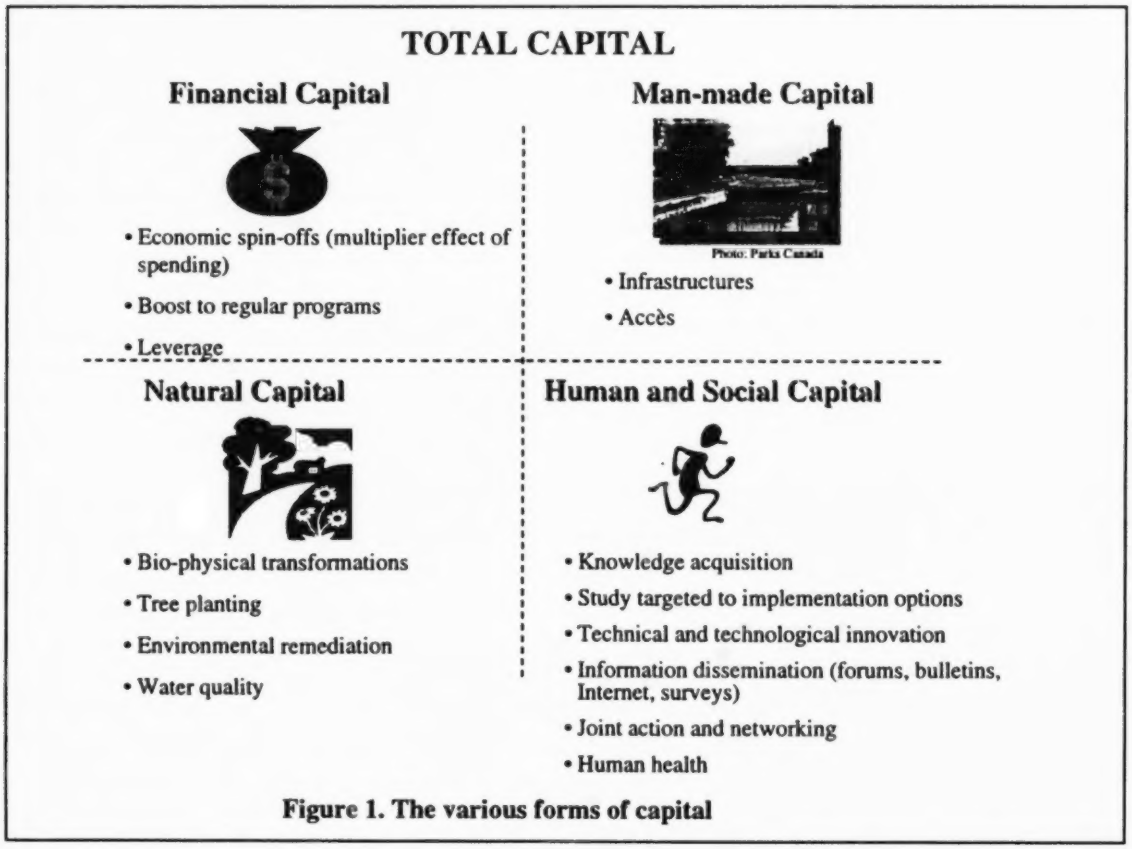

Figure 1. The various forms of capital

2.2 Measurement of benefits

For this evaluation, we are attempting to determine to what extent the SLV 2000 program, Phase III, has been able to help improve the situation of these various forms of capital by generating various benefits (understood as relating to sustainable development). More technically, the objective is to define the marginal benefits generated by the Plan in terms of the costs incurred (the various government partners' financial effort).

For that purpose we have put together an assessment grid, based on these various forms of capital, to detail the various benefits that could be ascribed to SLV 2000 Phase III. The notion of capital, first developed as a measure of a nation's production capacity, is used here in the context of consumption, that is, the needs of the people of Canada and Quebec affected by the Plan. A connection therefore is required between the initial definitions and the way these definitions are interpreted to take into account the economic effects of Phase III of SLV 2000.

Apart from the variety of forms of capital, examples of which are given to provide general background, the grid shows how capital may be converted from one form to another, financial capital being generally used as the basic reference in the cost/benefit analysis.[5]

SLV 2000 Phase III is therefore more than an "environmental" Action Plan in the classical sense. It speaks to the participatory concerns of St. Lawrence riverside communities: safe public access, human health, and partnership—and hence the specific interest in integrating the impact on human and social capital.

Also, SLV 2000 Phase III gave rise to an organization suited to the issues the Action Plan deals with, which allowed administrative follow-up to be done at the same time as results indicators were being generated for each component. The variety of results generated is a valuable information base for purposes of analysis and a prerequisite for the definition of the main benefits. The Management Tracking System (MTS) is the key tool in this context (see Appendix 2).

The information contained in this system was supplemented by a series of targeted discussions[6] aimed at obtaining additional information from co-chairs and co-ordinators of the various components, as well as project officers, in order to achieve the following three objectives:

- provide a more complete definition of the various tangible and intangible benefits;
- obtain a more precise assessment of the benefits;
- estimate the specific proportion attributable to the Action Plan as opposed to other government initiatives.

For purposes of this study, the results are presented not by component but by form of capital. Presentation by component could be relevant from an administrative standpoint or for purposes of internal assessment. Nevertheless, it was decided not to present the data that way, taking instead a more pragmatic approach in the sense that SLV 2000 Phase III results are aggregated and summarized to bring out more clearly the strengths and the synergy between the components.

A number of result indicators were originally developed to gauge the effects of SLV 2000 Phase III,[7] but for purposes of this evaluation we deemed it necessary to make a selection. Again, as not all sources of economic value potentially attributable to the Action Plan could be identified in this study, its benefits are probably under-estimated.[8] Therefore, the estimate given in this study for the Plan's benefits should be considered a lower limit.

That being said, there are certain limits on the ultimate effects of actions, such as the impact on biodiversity or on regional development. Whenever this is the case, we shall be issuing the usual disclaimers. From the standpoint of economic rationality, there is also a need to avoid runaway study costs—something Treasury Board (Consulting and Audit, 1995) acknowledged when it emphasized that in some cases orders of magnitude should be looked for rather than precise figures.

To do so, however, we shall need to use various evaluation techniques, each with its strengths and weaknesses from the standpoint of economic measurement. So, the approach taken is to make the most judicious possible choice of measurement technique in view of the type of benefit identified; a single approach will not do, as the results are so varied.

The selected evaluation techniques will be presented briefly in order to outline their main characteristics and how they will be used under SLV 2000 Phase III. The description is based on the literature,[9] but also makes the link with special features of the Plan outcomes. Certain evaluation techniques refer to benefits that can be directly measured in a well-defined market or from readily available financial data.[10] Others refer to benefits that cannot be so measured. Five main techniques were chosen, in addition to a value transfer approach (see Appendix 1):

- measurement of leverage;
- measurement of costs saved;
- measurement of opportunity cost;
- measurement of replacement cost;
- measurement of contingent valuation in a notional market;
- measurement by value value transfer and meta-analysis.

To fully ascertain the benefits that may be ascribed in whole or in part, directly or indirectly, to SLV 2000 Phase III, it is important to choose a set of techniques suited to the nature of the results.

In particular, value transfer will be used to bring out and reveal the (generally hidden) value of certain economic benefits (e.g. biodiversity).[11]

2.3 Measurement of costs

Direct costs listed in the Action Plan are the sum of all financial commitments, that is, capital, operating funds, etc. These costs are associated with new money from the Treasury Board of Canada and its Quebec counterpart (amounts paid during Phase III of the Action Plan) in addition to the regular program funds spent in support of the Plan. They are therefore direct expenditures made by, or at the behest of, the various partners in SLV 2000 Phase III, that is, eight federal and five provincial departments.

Identification and calculation of costs has been made possible by a system for producing balance sheets associated with the Management Tracking System (MTS) (see Appendix 2). We have been able to verify all sums committed by department, component and type of expenses (e.g. salary, operations) on an annual and cumulative basis. The cost accounting exercise was therefore greatly facilitated for the first four years and the planning data for 2002-2003 were used to complete the expenditure profile.

Finally, there is a need to take into account the indirect economic cost of public expenditures. An assessment should therefore be done of the capital cost of public expenditures, that is, the opportunity cost of allotting these sums to SLV 2000 Phase III rather than to other government expenditures.[12] Total actual expenditures (financial cost), to which must be added the capital cost of these expenditures, constitute the total economic cost of the SLV 2000 Action Plan.

2.4 Cost and benefit comparison

The fundamental justification for the cost/benefit analysis is the need to compare benefits and costs on a common basis, preferably financial, in a synchronous way (that is, for the same period) and for an appropriate impact zone. Using this comparison, it will be possible to assess whether the action, in this case the St. Lawrence Action Plan, is economically justified in view of the expenses incurred.

In the case of SLV 2000 Phase III, the expenses were incurred in the course of the 1998-2003 period, whereas benefits may have begun to be generated in 1998, but will probably continue after the end of the Action Plan, therefore after 2003. To complicate the exercise, there were also earlier action plans (Phases I and II) which have a cumulative effect on present and future benefits. And then there are other programs, such as the Quebec Wastewater Treatment Program (PAEQ), which first targeted large cities, then smaller municipalities, that have also helped improve certain characteristics of the environment, such as water quality. Caution is needed, therefore, in interpreting the benefits of the SLV 2000 Action Plan, Phase III. Accordingly, certain benefits are ignored where the risk of double accounting is too high or there seems to be little justification for assigning the impacts to SLV 2000 Phase III.

Another point: we shall be doing a sensitivity analysis by varying the discount rate.[13] This allows us to compare benefits and costs that are realized at different times and to take into account discount rate fluctuations as the economy changes.[14] The discounting principle relies on the fact that individuals, investors and governments are more sensitive to short-term effects (benefits and costs or gains and losses) than long-term ones. In fact, they only prefer a long-term benefit where the expected yield (net benefit)

in the long term is significantly more than the immediate yield (interest principle).

As for the impact zone, we are limiting our analysis to Quebec[15] and, where data are available, to riverside communities (inhabitants of municipalities along the shores of the St. Lawrence). In this way we are actually under-estimating the benefits, as inhabitants of other provinces or territories that also use the St. Lawrence may also benefit, either directly (when touring Quebec) or indirectly (because of interprovincial economic links, as in the case of commercial activity related to marine transportation).

2.5 Economic spin-offs

Economic spin-offs, though traditionally included in a socioeconomic assessment, are not strictly speaking part of the cost/benefit analysis. Rather, they give the evaluator additional information: an overview of the plan's impact on the regional economy, in this case Quebec's. The figures for economic benefits and spin-offs should therefore not be summed.

The purpose of evaluating economic impact or spin-offs is to account for the direct and indirect effects of expenditures generated by completion of Phase III of SLV 2000 on the regional or national economy.[16] Such indicators as value added to the economy, government revenue—including the value of business-related exports and imports—and jobs maintained or created are used to illustrate these effects.

All government expenditures will have such effects, which are evaluated in terms of money flow, no matter what their nature or purpose. In the case of SLV 2000 Phase III, the total expenditures will have an impact like that of any government program expenditures.

As with any model, it is important to distinguish the possible impact of expenditures according to the model from the actual effects, which are almost impossible to measure directly (because it takes too long, the cost is prohibitive, or there are technical difficulties). The spin-offs must therefore be understood as indications of the economic effect of SLV 2000 Phase III in Quebec.[17]

3 RESULTS

The impact of Phase III of SLV 2000 is felt on various forms of capital; we shall present them now. In reporting results, we have been concerned to evaluate their (explicit or implicit) financial aspect so as to quantify it in socioeconomic terms.

3.1 Financial capital

The results, in terms of financial capital, have been to reinforce and expedite certain regular programs and exert a lever effect on the economy as well as to generate economic spin-offs from the Action Plan expenditures.

3.1-A Reinforcement of regular programs

That regular programs were reinforced is clear from the ratio of new money (SLV 2000) to regular program funding; to be precise, $30 million in new money and $226 million in regular program funding was used to achieve the Phase III results. We see from this that **for each dollar of new SLV 2000 money, the various departments contributed nine dollars.** Conversely, the Plan provided support for a set of established programs and, by creating greater synergy, enhanced their viability. Many stakeholders feel that if it had not been for the commitment made under Phase III, the St. Lawrence would have taken a back seat to other priorities or, again, regular program expenditures would have been less over the same period.

The effect on programs was stronger in Phase III than in Phase II, as a lot less new money was on the table.

3.1-B Extragovernmental leverage

Beyond government efforts (those of Action Plan partners), external contributions on the order of $927,000 were made during the 1998-2002 period (four years; an average of $232,000 a year).[18] Extrapolating to the end of the Plan, that will mean a total of some **$1.16 million in contributions from domestic and foreign non-governmental organizations** (e.g. France, USA). An important part of this contribution comes from the International Joint Commission, which is concerned with the issue of water level variations in the St. Lawrence. The IJC contribution is new and will be continuing after 2003.

3.1-C Environmental leverage: co-operation on local project financing

The riverside communities themselves also made a far from negligible contribution, in particular through private and community contributions to commitments to particular projects. Such co-operation was seen in particular at the level of the Community Interaction program, which provides up 50% of the funding for particular projects proposed by the Area of Prime Concern (ZIP) committees and other local non-governmental organizations.

From 1998 until March 2002, the local community (industry, local governments and various organizations) invested a little more than $6.96 million in carrying out field projects.[19] Should the trend continue into 2003, which on the basis of some of our discussions seems plausible, the local community's contribution could be as much as $11.6 million, or **an average of $2.32 million a year.** The funding was also found to be **leveraged by about a factor of**

1.6, which means that for each dollar invested by the Community Interaction program, the local community invests $1.60. This continues the investment pattern begun with Phase II of SLV 2000 (1993-1998), which supported the creation of this program.

Between 1998 and September 2002, of the 287 projects submitted by 107 environmental organizations, 135, 63% of them related to ZIP committee[20] ERAPs (Ecological rehabilitation Action Plans), were financed by the Community Interaction program. This clearly illustrates the importance of community commitment in the conduct of SLV 2000 activities.

3.1-D Agricultural community's financial contribution to a program's success

The Quebec government's agro-environmental program in support of the pest management strategy was implemented in 1998 to support the pest management strategy developed by the Quebec department of agriculture, fisheries and food (MAPAQ). The program is intended to rationalize the use of pesticides that could contaminate soils and watercourses. SLV 2000 Phase III, by providing a good part of the financing (three quarters of the total), helped raise farmers' awareness of effective pesticide management.

Because this program deals with diffuse pollution, and farm producers are at once so numerous and spread over so large a territory, their effective co-operation must be secured in the field. To that end, over the 1998-2001 period, the program invested some $1.7 million and generated about $1.3 million in investments by other local stakeholders, for a lever effect on the order of 0.76, or 76%. Extrapolating this to the whole 5-year period, the cumulative leverage would be on the order of $2.1 million, or **an annual average of $0.42 million.** SLV 2000 had a strong coattail effect throughout the St. Lawrence watershed, a territory where a lot of farming is done requiring the use of pesticides.

3.1-E Industry's financial involvement in restoring contaminated aquatic sites

Another SLV 2000 initiative dealt with efforts to clean up sediments, and particularly the prerequisites for such efforts, namely joint action and financial arrangements to ensure they are carried through (St. Lawrence Vision 2000, 2002). Two projects in particular are receiving sustained attention, namely:

- aquatic sector 103 adjoining the docks in the Port of Montreal;
- the mouth of the St. Louis River

In the first case (sector 103), a partnership has been formed between a ZIP committee (supported by the Plan) and four industrial partners. The latter are ready to make a contribution totalling **$5 million.** In the second case, a partnership between another ZIP committee (also supported by the Action Plan) and two other industries led to a **$3- to $5-million** funding agreement for restoration of contaminated sediments in the St. Louis River.

In addition to departments' regular efforts, the contribution of Phase III helped put in place conditions that facilitated the conclusion of voluntary funding agreements with industry at minimal cost (interview, project officer, 2002). Institutional support and community capacity were assured, and

in both cases, the money involved is money governments will not have to pay (cost saved).

Finally, a "model" effect seems to be at work, as there has recently been some interest shown in other decontamination work (Sandy Beach port in the Gaspé) (interview, project officer, 2002). It should be noted that the financial arrangements, whose effect will be measurable in Phase IV, built upon the efforts of the two earlier phases (I and II), when the requisite chemical characterization was done and partnerships formed with ZIP committees.

Although we have no data as to the social *desirability* of these projects, a recent Great Lakes region study showed that households were willing to pay between $100 and $300 apiece for a river in Wisconsin (Stoll *et al.*, 2002). As the effects of decontamination work can generally be seen over a long period, the benefits of these decontamination projects will be felt only in the long term.

3.1-F Economic spin-offs

With respect to the economic spin-offs,[21] Action Plan spending allowed some 3,719 direct and indirect jobs to be created or preserved; a GDP increase (value added) on the order of $218 million; $38 million worth of imports; and provincial and federal revenues[22] on the order of $26 million and $17.4 million respectively (Figure 2). The multiplier effect of program spending, in terms of value added, is on the order of 84%; in other words, $0.84 in value added was created for each dollar spent under the Program—a highly respectable economic contribution. The figure below illustrates the flow of economic spin-offs.

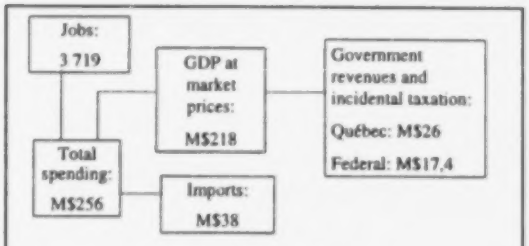

Figure 2: Flow of economic spin-offs (based on 1998 dollars)

The opportunity cost of these expenses would be 4.8% a year.[23] This additional cost needs to be taken into account, as it lessens the economic impact. This cost, however, applies only to new capital ($30 million, after correction),[24] which would not have been invested if the St. Lawrence Action Plan had not been agreed to. As regards amounts related to regular programs, we may assume that they would in any case have been invested by departmental stakeholders in the St. Lawrence or its tributaries. The cumulative opportunity cost over five years on the $30-million base implies a possible capital loss of $7.93 million (on the assumption that this amount would be available on the financial market and would in fact be used).

3.2 Man-made capital

"Man-made capital" means all infrastructure created to ensure sustainable development. Under the SLV 2000 program, the components that helped increase this capital are mainly the Agriculture and Biodiversity components.

SLV 2000 Action Plan Phase III was not designed as an infrastructure development or building plan. Results in this area are therefore limited. That being said, a certain amount of strategic infrastructure does exist for wildlife and for St. Lawrence River access.

3.2-A Reopening of the Lachine Canal to recreational boating

One infrastructure project in which Phase III helped, but also (and especially) phases I and II, is the reopening of the Lachine Canal.

This project, whose main goal was to increase boaters' access to the St. Lawrence, received funding under previous phases of SLV 2000. At that stage, pollution sources were identified and decontamination options considered (Boulanger *et al.*, 1998). Following on from Phase II, assessments of how likely contaminated sediments were to go back into suspension helped in choosing the best ways of managing those sediments—either removing the most severely contaminated sediments from the aquatic environment (as in Peel Basin) or sealing them in with a geotextile membrane. SLV 2000 Phase III then facilitated the partnership between Parks Canada, Canada Economic Development and Environment Canada.

Once the environmental acceptability of the project was proved, the opening of the canal went ahead in May 2002. Although it is still too soon to gauge its impact,[25] preliminary data indicates that more than 4,200 vessels passed through between May 17 and August 30, 2002, for an average of 280 passages a week (with ups and downs, of course, during that time).

An evaluation done by Zins Beauchesne and the SECOR group (1997) showed that the reopening would make it easier for small craft—for local recreational boaters and visitors from Quebec, Canada and the US—to get upstream or downstream of Montreal. Based on the fees charged in 2002 and a typical length of 17 ft (small craft), the direct lockage cost may be estimated at $21.25/day, not including other, indirect expenses. If we assume that each passage cost only that minimal amount, direct expenses from mid-May to the end of August were $89,350 and may have been as high as $113,000 at season's end (if we add four more weeks of average traffic).

Little data is available on indirect expenses in materiel, food etc. One recent study estimated that in Quebec, average daily expenditures (use value, disregarding the consumer's surplus) would be some $130 per user for a kayak-type craft (Archambault *et al.*, 1999). Although this figure would be hard to generalize, it does indicate that indirect expenses may be quite high and that the use value of recreational boating is far from negligible.

Finally, the reopening of the Lachine Canal contributes to urban renewal and to the development of a series of secondary activities, many of which are managed by the *Pôle des Rapides* organization.

The benefits of the canal's reopening, which will make themselves felt during the last year of SLV 2000, will no doubt last well beyond its five-year horizon.

3.2-B Agricultural pollution management infrastructure

In agriculture, some producers have acquired waterproof manure storage facilities. As of March 31, 2002, 2,771 farm operations were in compliance with the Quebec regulations on agricultural pollution and had received assistance from the Quebec department of agriculture, fisheries and food (MAPAQ). This number is expected to reach or even exceed 3,000 by March 31, 2003. The operations that have taken advantage of the program are located in six regions, many

along the St. Lawrence or its tributaries. Funding for this program comes from regular MAPAQ money, granted to SLV 2000 as a partner.

In this case, even though the focus is on infrastructure, the underlying issue is still the environment and public health. A study by Lamari and Landry (2000) showed that in certain regions strongly affected by diffuse agricultural pollution, residents spent an average of $263 per household, per year on bottled water or individual water processing devices. The same respondents indicated they were willing to compensate agricultural producers by as much as $113 per household, per year, for polluting water less.

Considering the number of households along the St. Lawrence—1,520,000 according to the health survey (Dewailly *et al.*, 1999) — and the amount they are willing to pay to reduce agricultural pollution of water sources ($113/household/year), this would bring the estimate to $171,800,000/year. This value is obviously based on a small sample and is not necessarily representative of the situation everywhere along the St. Lawrence, but it may be relevant to certain very agricultural watersheds, such as those of the Yamaska, L'Assomption and Chaudière. Applying this figure onto a total population of 784,000 for these three watersheds (196,000 households)[26] produces a more realistic estimate of about **$22.15 million a year.** Apart from the uncertainty as to how excess manure should be dealt with, this estimate gives some indication of the importance of the water quality issue for residents, given the agricultural pollution situation.

3.2-C Development of river access along the St. Lawrence

The new river access points provided at St. Barthélemy, Châteauguay, Lachine and Neuville and those under construction at Boucherville, on Lavallière Bay and at Baie du Febvre are SLV 2000 Action Plan infrastructure, and indeed were developed using new money (SLV 2000). These access points are to be supplemented by others now under construction or for which feasibility studies are in progress, for example at Lachenaie, Maple Grove, Baie St. Paul and Sainte Rose du Nord. The infrastructure consists of reception, parking and picnic table areas.

Neither the scope of these infrastructure projects nor their current or forecast usage was known at the time this study was carried out. Nevertheless, there is a clear need. The number of riverside dwellers who enjoy walks along the shore is very high on the St. Lawrence. According to the health survey *Enquête santé sur les usages et perceptions du Saint-Laurent* (Dewailly *et al.*, 1999), more than 1.66 million persons say they "sometimes" or "often" take a walk along the St. Lawrence; the total rises to more than 2 million river-dwellers if we count those who say they "seldom" walk along the St. Lawrence (in all, some 28% of the total population of Quebec).

However, we have no figures for the spending connected with these outings; an earlier study, from the early 1980s, i.e. at the time of the Archipelago project (Montreal region), estimated the spending associated with one day of walking and picnicking at about $3.25/person, or about the same as for sports fishing.[27] Recently, in a national survey on the importance of nature-related activities (Leigh *et al.*, 2000), the figure cited

for similar activities was an average of $34/day (though this did include swimming, cycling and other summer and winter outdoor activities). This value is certainly more realistic than the one previously mentioned.

If we consider a conservative scenario (one spending day per user), the economic value could be as much as $56.44 million a year, not to mention the intangible benefit of the pleasure of the outing and the psychological boost it may provide. As precise data is lacking, and in view of the existence of well established access points, it is realistic to suppose that the contribution of these new ones is marginal.

Considering the number of visitors to the St. Ours canal (48,677 visitors to the canal area in 1995), another access point supported by SLV 2000, the total number of visitors may be estimated to be in the tens of thousands. In the absence of precise data, we shall use this figure (50,000) for all access points, and, multiplying it by the estimated daily spending value ($34/day), we obtain an estimated total of **$1.7 million a year.** This may serve as a rough approximation until such time as precise per-site data can be used to provide a more accurate value.

3.3 Natural capital

Natural capital may be evaluated based on the physical resources (stocks and flow) available and maintained, or on the values assigned to these resources. For the St. Lawrence watershed, a breakdown has been done based on the national survey on nature-related activities.[28] The data shows the following profile:

- 2,131,000 participants in outdoor activities (representing 85.5% of all such activities in Quebec);
- 1,078,000 participants in wildlife-related travel (representing 88.8% of all such activities in Quebec);
- 791,000 participants in the sports fishery (91% of the Quebec total);
- 835,000 participants in swimming and beach activities (87.6% of the total for Quebec);
- 432,000 participants in canoeing, kayaking and sailing (89.6% of the total for Quebec); and
- 288,000 motor boaters (88.9% of the Quebec total).

In view of the geographic size of the watershed, it is more accurate, however, to refer to the population dwelling immediately beside the St. Lawrence. That being said, this data gives us an overview of the importance of the St. Lawrence watershed, including tributaries, to Quebec as a whole.

3.3-A Fish species and use value in the sports fishery

Aquatic pollution, and contamination of particular species, has generally been lessening for more than two decades, and PCB and mercury contamination is well within guidelines for fish consumption (Coad *et al.*, 1998). However, Phase III will have a low impact in this area compared with the efforts undertaken in the two previous phases.

Still, the recreational fishery, which depends on unpolluted fish, continues. In Quebec, one day of fishing entails spending of around $29 according to a survey on the importance of nature-related activities in Canada carried out by Leigh *et al.* (2000).

It appears there are close to 262,000 persons who fish in the St. Lawrence River or the Gulf, at least once a year, according to the information from another survey done for the SLV 2000 Action Plan (Dewailly *et al.*, 1999).[29] On that basis, the value of this use may be put at around $7.6 million a year; but that does not take into account the more than 50,000 persons who say they also fish in the winter (ice fishing).

Fish is also a valuable food source (and is recommended by Canada's Food Guide) because of its protein, vitamin D, phosphorus and selenium content. Fish is also a source of omega-3 fatty acids, compounds that may contribute to the reduction of cardiovascular disease (Dewailly and Blanchet, 2000). This knowledge may lead to more rational, less abusive consumption of fish with due regard for risks to public health.

Finally, a little-known aspect of the fishery has been revealed by a study financed under Phase III. Apparently fishing has a psychosocial impact that benefits residents' quality of life.

In particular, fishing smooths family contacts and reduces the number of violent episodes while improving both children's and adults' self-esteem. These benefits may even be greater than the food value of fish consumption (Grondin *et al.*, 2001). This is an unsung indirect benefit that flows from the health and abundance of the fish stocks.

Even if the relationship cannot be quantified or "monetized", it may be assumed that any investments in access, decontamination of aquatic environments or support for fish populations are real contributions to maintaining these benefits.

3.3-B Waterfowl consumption

According to a recent public health research study (Duchesne *et al.*, 2001), there is little risk for hunters in consuming the flesh of waterfowl, whether from exposure to mercury, selenium or a variety of organochlorines. The report adds, since hunters are often avid fishers as well, that there appears to be no danger in consuming both fish and waterfowl. No rules need be laid down, therefore, for consumption of game, and so another wildlife use can go on without restrictions.

The cleanliness of the St. Lawrence and the support for waterfowl populations for which the various phases of SLV 2000, together with regular program efforts, are partly responsible, are thus allowing waterfowl hunting to continue.

3.3-C Protection of St. Lawrence shores

One of the main features of the St. Lawrence is the length of its shoreline, which is several thousand kilometres when we add in both riverbanks, in fresh and salt water, as well as the circumference of all the islands. Shoreline protection is therefore a big priority.

Under SLV 2000 Phase III, one measure is being taken that seems to have much reduced shoreline erosion and loss: the adoption of voluntary reduction in speed for ships in a particularly sensitive zone (between Varennes and Contrecœur). This has been achieved through the co-operation of St. Lawrence pilots and private shipping companies since the spring of 2000 (St. Lawrence Vision 2000, 2002). At a rough estimate, pending more precise results, this speed reduction in a particularly sensitive stretch of twenty-odd kilometres

has resulted in about a 50% reduction of shoreline erosion.

The "monetized" environmental value of this measure, if we equated it to the cost of replacing a natural shoreline with an artificial mechanical barrier, would be quite high. Supposing it would cost close to a million dollars per linear kilometre to artificially reduce shoreline erosion,[30] the measure may be considered to have produced a benefit of at least **$50 million** in costs saved (25 km multiplied by 2 shores) thanks to Phase III, not to mention the impact on island environments. However, a few qualifications are called for. First, rationalization could reduce the costs of "artificializing" this length of shoreline. Also, any major man-made shoreline protection would no doubt require a costly environmental evaluation, which has not been considered here. Finally, this value is seen as relevant only insofar as the damage prevention lasts beyond Phase III.

3.3-D Improvement of shoreline condition by local communities

At the local level, communities too are making major efforts to improve the condition of shorelines on the St. Lawrence and its tributaries. Three indicators of that condition were tracked from 1998 until March 2001 and extrapolations were made to the end of Phase III in accordance with the responses obtained in interviews, which confirm that there was a linear progression of results:

- 253,288 plants replanted ($12/plant including labour and materials);
- 378.3 km of shoreline in all ($231,000 for protection of a 150-m band of shoreline);
- 1,280 t of waste gathered and recycled (recycling earnings = $70/t + $30/t (landfill costs saved) + cost of waste removal = 3.55 h/t multiplied by $6.70/h);[31]
- 128.3 ha protected, preserved, restored or enhanced ($22,500/ha).

If the same figures are applied as were chosen in 1998 for the study of Phase II, the results are as follows:

- replanting and reforestation efforts = $3,039,000 (5 years);
- shoreline clean-up, stabilization or restoration = $87,387,000 (5 years)[32];
- waste removal: $158,445 (5 years);
- hectares protected, preserved, restored or enhanced: $2,886,750 (5 years);

The grand total for all four types of work considered here is $93.5 million, or an average of **$18.7 million a year** for the whole of the St. Lawrence and its tributaries.

Whereas the total support spending for these activities (ZIP Program and Community Interaction) totals about $13 million over five years, the field activities' benefits were seven times greater than the program spending. The ratio is therefore about one to seven.

3.3-E Protection and conservation of St. Lawrence wetlands

Another measure taken under the SLV 2000 Action Plan is aimed at the protection of habitats along the St. Lawrence River and the Gulf. To date (August 2002), the area of natural habitats preserved by various means is estimated at 107,000 ha, including the

consolidation of national parks (80% of the area concerned).

These areas make a more indirect contribution to residents' well-being in that they render "ecological services". De Groot (1994), one of the first to address this, emphasized that the services rendered by wetlands may be grouped into four major categories of "ecological functions" (see Appendix 1):

- the regulation function;
- the support function;
- the production function;
- the information function.

Not all of these functions are compatible, although the value of each and its contribution to collective well-being is recognized. Again, it is acknowledged that each function may be further broken down into subfunctions, each of which has its specific value. In this context, the simultaneous expression of these values may be of very great importance.

The diversity of ecosystems within the 107,000 protected hectares would be difficult to evaluate rigorously. In what follows, therefore, we shall merely be giving an indication of the orders of magnitude we are talking about.

The value of a habitat may be derived in the simplest possible way from the species that depend on that environment. For that reason, we often focus on a key species, whose value is measured through the lens of the recreational spending devoted to it. In 1993, for example, Van Kooten put the value of Canada's wetlands, in waterfowl alone, at \$50 to \$60/acre (one acre = 4,047 m^2). That study, in Nunes and Van den Bergh (2001), is one of the most relevant to our context. The value of the wetlands preserved, according to this estimate, is between **\$13.2 million and \$15.9 million a year.** In our opinion, however, that estimate may be seen as a minimum in view of the spending on various recreational activities, such as hunting and fishing (\$29 to \$50/day/person in 1996), or on other nature observation recreational activities (\$17/day/person in 1996) (Leigh *et al.*, 2000).

Another way of estimating the value of ecosystems is to ask households how much they are willing to spend to ensure their conservation. Nine US studies conducted between 1984 and 1995 showed a range of values extending from just \$4/household/year (protection of Lake Mono, California) to \$184/household/year (wetlands in the San Joaquin Valley, California). Between these extremes, a number of average values were found: between \$10 and \$40/household/year. Although it is difficult to transpose the figures, the value of \$10/household may be considered realistic; multiplying this by the approximately 1,520,000 riverside households of the St. Lawrence (Dewailly *et al.*, 1999), we obtain a total of **\$15.2 million a year** (some being willing to pay more—as recreational users' expenses were between \$239 and \$726 a year—and others less).

A better calibrated analysis of the assessments done in various contexts shows relatively high values based on the diversity of the ecological services rendered. If we consider only one service (supply of habitat) common to all ecosystems, the value of which is set at \$306/acre (applying no Canadian/US currency conversion nor discounting to this value, which dates from 1990), the total value of the 107,000 ha protected would be \$80.8 million at the end of the fifth year. The level of protection of

these territories, at the rate of 21,400 ha a year (52,858 acres) translates into a benefit of some **$16 million a year** (but this value increases year by year).

Table 1
Examples of values assigned to wetlands

Ecological function	Average value (1990$/ acre)	Minimum/ maximum value (1990$/acre)
Flood protection	393	89-1747
Recreational fishing	357	95-1342
Commercial fishing	778	108-5618
Waterfowl hunting	70	25-197
Birdwatching	1212	528-2782
Supply of habitat	306	95-981
Storm protection	237	11-5142

Based on data from Woodward and Wui (2001).

The cost of the three approaches presented above varies from about $13.2 million to $16 million a year, even though they rely on very different modes of evaluation. To compare costs and benefits, we shall split the difference and use a value of **$15.2 million**, so that the total value to St. Lawrence river dwellers over five years would be $76 million.

A more comprehensive assessment, and based on all wetlands the world over (Costanza *et al.*, 1997) proposed values on the order of US$4,540/ha/year for the control of natural disturbances (and the same for protection against flood, storm etc.), plus US$3,800/ha/year for water supply, plus US$4,180/ha/year for waste recycling (wastewater processing function). If we use these data, the value previously assigned will have to be multiplied by 40. The estimate we have used is therefore a very cautious one.

3.3-F Wildlife protection and fish ladder

The St. Ours dam fish ladder is one of the Plan's achievements. The project is said to be unique in the world, as instead of being suited only to one species, this fish ladder can be used by different fish species, including the copper redhorse. It appears that for that reason the project will be giving rise to a technology transfer. Enquiries have been received from France, Belgium and the USA about building similar fish ladders the Canadian International Development Agency is interested in using the technology in Vietnam. Another project spin-off has been a premium beer, Rescousse. A royalty is paid on the proceeds from the sale of this beer to the *Fondation québécoise de la faune* to help save endangered species in Quebec.

It should be emphasized that in the particular case of the copper redhorse, a rare and primitive species that is no doubt a survival from an earlier ecosystem many thousands of years old, a contingent valuation exercise was done in 1997. This academic study showed that the copper redhorse could be assigned an existence value of some $25 million.[33] Of course, the possibility of replacement, for this extremely rare species, is virtually nil. By June 2002 the effectiveness of this fish ladder for the copper redhorse could already be seen.

Also, an evaluation of the St. Ours Canal National Historic Site of Canada indicated that around 38,000 visitors a year could be expected, and that they would spend some **$232,000/year,** specifically because of the development of the fish ladder (Gosselin, 1997).

3.4 Human and social capital

Human and social capital consists mainly, but not exclusively, of knowledge, awareness and training gained and networks for exchange and co-operation created by the various stakeholders, as well as potential gains in the area of human health.

3.4-A Communities' investment of time

SLV 2000 Phase III has carried on the support given in Phase II to various community initiatives, and as led to an investment of time by riverside communities.

One of the first concrete results of this has been ZIP (Area of Prime Concern) committees acting as regional and local issue tables. These tables have succeeded in stimulating more than twenty-five industries, eighty municipalities and twelve MRCs, forty economic organizations, sixty community and environmental organizations, twelve school boards and seven regional agricultural unions to take action. That participation is particularly notable when we consider the hours of volunteer work put in: 68,067 hours over three years, or an annual average of 22,689 hours. The extrapolated total over five years is therefore 113,445 hours, about the same as for Phase II of the St. Lawrence Action Plan, so there has been no letup in community participation.

If this time is evaluated on the basis of its associated opportunity cost (alternate uses of the work time) at the minimum wage of seven dollars an hour, the value of the volunteer work could be conservatively estimated at **$158,823/year**, or $794,115 over five years.

ZIP volunteer work is also a factor in carrying out field projects financed in part by the Community Interaction program. It has been estimated that 2,885 person-days of work was done between 1998 and the summer of 2001 (two and a half years) (Roy, 2001). Extrapolated to the end of Phase III of SLV 2000, this gives a (plausible) figure of 5,770 person-days; the total additional value of this work time, calculated on the same basis (one day = 7.5 h), would be nearly $303,000, or **$60,600/year.**

Finally, there is a network of volunteer watchers along the St. Lawrence who participate to varying degrees in monitoring the state of their environment or certain pressures that could change it.

The Biosphere's Ecowatch Network (BEN), supported in part by SLV 2000 Phase III, has had an average membership of 4,243 persons a year,[34] whose volunteer work averaged nearly 70,000 hours a year (their cumulative time over four years is estimated at 279,000 hours, with a more or less regular progression). The Ecowatch Network has seventy partners (schools, municipalities, ecotourism associations) working on information-gathering projects on fish, marine mammal watching and water quality.

Over five years, assuming total hours increase by 30,000 (very plausible in the light of previous data), close to 310,000 hours of volunteer work will have been done by the Ecowatch Network. In all, its value may be estimated at close to $2.17 million over five years, or an average of **$434,000/year**, if paid at minimum wage ($7/h).

Of course, the Network would have been able to function without the Action Plan. However, it took advantage of a synergy, in particular with the ZIP committees and the various co-operative committees set up

under Phase III, to improve its performance (interview, March 2002). Altogether, the value of the volunteer work could be as much as **$653,400/year**, for a cumulative total over five years of $3.267 million.

3.4-B Co-operation between sectoral decision makers

Under Phase III, various co-operative committees were set up in order to better co-ordinate action and optimize the individual efforts of the various governmental stakeholders, in some cases through more direct community approaches. In this regard, the Navigation issue table is a model. It brings together government partners in transportation and the environment while leaving room for community stakeholders, representatives of the recreational boating sector and the shipping industry. Some stakeholders[35] find a number of advantages in this, such as:

- easier exchanges, improved relations and less conflict;
- an increased understanding of the various stakeholders' responsibilities and constraints;
- a start on innovative action (e.g. a voluntary reduction of the speed of commercial shipping).

These exchanges also facilitated the discussion of horizontal issues beyond the scope of a conventional sectoral vision. Stakeholders in the various areas of activity have a better understanding of each other's roles and the constraints everyone is subject to. These exchanges also afford an opportunity to develop common orientations and co-operate on future action—something the sustainable navigation strategy will be in a position to take advantage of, particularly between now and March 2003.

3.4-C Public dissemination of information on the St. Lawrence

SLV 2000 Phase III helped to inform the general public, and riverside communities in particular, about the river and some of its tributaries as well as the action being taken to improve their condition. A number of important media were used by SLV 2000: the Internet, the bulletin *Le Fleuve*, ads in various magazines (with a cumulative potential circulation of 321,700 readers between 1998 and April 2002), various public consultations, forums or symposia attended by nearly 15,000, and other special events that may have reached another 14,350 people. Not only were a large number of people reached, it is thought that each person had access to information from a number of sources, thus reinforcing certain key SLV 2000 messages in the public mind.

Also between 1998 and 2000, about 200 Internet announcements were made and 80 articles published in *Le Fleuve*.

For the years for which web counts are available, the following statistics were noted:[36]

- 12,000 to 14,000 sessions a month on the average (January to April 2002), one session meaning one visitor;
- 2,300 page or document printed per day (January to April 2002);[37]
- 30 minutes per session, per day on the average, for 400 sessions a day[38] (200 h/d).

This data shows our data use at a certain "cruising speed". Although the figures are higher than in previous years, they are still below the instantaneous rate of increase

shown on the website (interview, project officer, May 2002).

If time spent on the site is valued on the basis of the opportunity cost of an hour of work (minimum wage: $7/h),[39] the 200-h duration of the average web session, at $1,400/day multiplied by 350 days (excluding statutory holidays), brings us to nearly **$490,000/year** (or $2.45 million over five years). (This is a measure of the site's "opportunity cost", that is, the value of time that might have been spent at another activity or on another website.)

Of course, these communications were about all Plan components, though to varying degrees. Probably they made the public more aware of the river and, especially, the efforts being made to make it more accessible and usable.

3.4-D Measurement and assessment of toxic effluents from municipalities and certain industries

Reduction of priority toxic substances and implementation of pollution prevention projects at SMEs targeted by SLV 2000 Phase III are longer-term objectives. The first requirement, from the cost-effectiveness standpoint, is to properly identify sources. The first two phases of SLV 2000 were concerned with the largest and most concentrated industrial sources. From now on, the focus will be on diffuse sources, which are harder to control.

Here, special efforts have been devoted to particular urban areas and small and medium-sized businesses (SMEs) that are harder to pin down as pollution sources.

In the first case, emphasis has been placed on measuring the toxicity of municipal effluents in the river and its tributaries. One result is that the example of the town of Granby will be used in other municipalities in an innovative evaluation approach with a view to possible action.

In the second case, SMEs were singled out. Some of them therefore adopted various means for reducing toxic discharges from their operations, though the results of these actions are not yet available. Phase III made it possible to ascertain what certain SMEs' share was in the discharge of toxic substances of industrial origin. This will be followed up, in the next Phase, with more precisely targeted action in the light of the knowledge gained.

3.4-E Institutional co-operation in monitoring the state of the environment

By facilitating exchanges between the various federal and provincial departments, SLV 2000 enabled a **state of the environment monitoring program** to be developed calling on the expertise and skills of four key departments: Environment Canada, the Quebec department of the Environment, the *Société de la faune et des parcs du Québec,* and Fisheries and Oceans Canada.

A comprehensive agreement between all these stakeholders has practically been completed; its scope is such as to ensure monitoring and dissemination of information on the state of the St. Lawrence[40] beyond the five-year timeline of the Action Plan. Under the agreement, the government stakeholders undertake to periodically provide environmental information on the state of the water resource and the St. Lawrence River and Gulf ecosystems. This outcome will enable better co-ordination of knowledge acquisition, information processing and its

dissemination, not only to river-dwellers, but also to anyone that takes an interest in the St. Lawrence.

In this last case, what is sought is an active appropriation of information based on a "responsible citizenship" approach aimed at taking action on the environment.

3.4-F Knowledge acquisition and reduction of risk to human health

Under Phase III, a number of studies were undertaken. Those studies that related to human health led to a reorientation of health follow-up activities to improve prevention and reduce risk to health. New issues were looked at and, in some cases, older ones were clarified, with beneficial effects on health programs (interview, April 2002). The impact is assessed, in particular, on the basis of the number of new applied research projects on the St. Lawrence and the expertise gained for the public health network (e.g. *Institut de santé publique du Québec*) (interview, project officer, May 2002) and for the community in general.

One element obtained from the health research has been the monitoring of prenatal PCB exposure of women on the North Shore (where this problem is particularly critical). This monitoring helped to improve public awareness measures on exposure to these contaminants, in support of the *Département de santé communautaire de la Côte-Nord* (interview, April 2002). These measures save money both for families and for society in general.

To give an order of magnitude for these costs, a US study on health care expenses for the first year of life for low-birth-weight children reported a value of about US$15,000 (1988)/child/year.[41] The incidence of low-birth-weight children is strongly correlated with increased concentrations of certain contaminants that may disrupt normal foetal development. Other effect have also been noted, in particular decreases in IQ, birth defects and various costs linked to excess mortality and morbidity (Cangelosi *et al.*, 2001). Even though no direct cause-and-effect relation may exist, there is no question that prevention is often a lower-cost solution and that a certain amount of prior knowledge is needed to make a better assessment of risk (and exposure pathways) before taking preventive action.

Another action is concerned with the use of St. Lawrence resources and in particular those of shellfish harvesting areas in the Gulf. Although there is an annual surveillance program for shellfish areas, the risk posed by problem sectors was not well known when it was set up. Accordingly, health network stakeholders have undertaken a specific study to take this issue into account.

A complete analysis was done of all information available on each of the reported shellfish poisoning cases (forty-eight episodes involving sixty-six persons between the spring of 1999 and the winter of 2001): declaration forms, epidemiological investigations, stool and blood analyses, MAPAQ and Canadian Food Inspection Agency investigation reports), to determine the link between the illness and the consumption of shellfish. This analysis was intended to identify, where possible, the source of contamination (specifically, two species of pathogenic bacterium: *Bacillus cereus* and *Clostridium perfringens*). Mussels were the most common cause in cases classified as "confirmed" and "potential". The shellfish usually came from a sales establishment

(restaurant, grocery or fishmonger's). A distinct benefit of the Action Plan has been knowledge of the risk and the use of the preventive measures that seem most appropriate. In some cases, the harm prevented might have been very serious, and even fatal to the users.[42]

In addition, an analysis was done of the mussels blamed for a poisoning episode in the summer of 1998 (Sauvé *et al.*, 2000). Among other findings, this study showed that cultured mussels could have levels of contamination four times as high as wild mussels, and a species as yet unknown (*Prorocentrum mexicanum*) could also pose a danger of diarrhetic shellfish poisoning. This new information will help prevent new incidents and improve the response to any new mussel poisoning incident. Although precise data is not available, this knowledge may eventually help reduce the cost of medication, consultation and various medical acts, and of course shellfish poisoning seriously affects the market for mussels.[43]

Finally, another preparedness initiative, in the event of an accidental chemical spill, was supported under Phase III of SLV 2000: an intervention guide (Guerrier and Paul, 2000) intended, in particular, to improve the public health network's ability to take action should drinking water intakes become contaminated. The guide helps the network to prevent the risk of contamination by water supply networks that are fed by the river (the St. Lawrence river proper, essentially). Even though no precise estimate can be given of the value of preventing contamination, the Walkerton case[44] reminds us the consequences of negligence in preventing contamination of a community's water supply. According to the investigators' published report, it resulted in seven deaths and serious illness for nearly 2,320 other persons, not to mention the indirect effects, such as work and school days lost and the anxiety the event caused.[45]

4. COMPARISON OF BENEFITS AND COSTS

To compare benefits and costs on a common basis, the time when they are obtained or incurred needs to be properly defined, as well as their recurrence in time and space. Therefore, the annual flow of costs and benefits, and their total amount if appropriate, throughout the Plan, will be given. Finally, a discount rate will be applied to reflect the depreciation over time of costs and benefits. As was indicated above (methodology section), the rate applied will be varied with a view to verifying the sensitivity of the results to the relative value of money. A comprehensive assessment of the Action Plan will be done on the basis of these figures.

4.1 Cost and benefit flow

Among the benefits, there is a need to distinguish those that are relatively direct, i.e. are more readily associated with the existence of Phase III. Where the connection is vaguer, either because it is harder to pinpoint cause and effect, or because the effects are partly attributable to earlier action plans, we consider the benefits indirect.

In Table 2, we have compiled the data previously presented in section 3, taking into account the nature of the benefit, i.e. whether it is obtained yearly or only once during the life of the Action Plan. We then extrapolate and discount the benefits over periods of five and twenty years (Table 4).

The results presented in Table 2 are only part of the actual benefits, as measures are unavailable for many benefits (commercial value, other use values, option value and existence value). More important still, leverage is excluded from the comparison of benefits to costs, because it appears to be a more direct financial impact than the other components of the benefits listed. Though leverage is presented separately, it is none the less apt to enhance the other forms of capital (man-made, natural, or human and social) in the long run.

Table 2
Compilation of selected benefits of Phase III

Direct effect	Annual benefit (CA$)	Benefit over 5 years (CA$)
Financial capital		
Leverage – extra-governmental investments	232,000	1,160,000
Leverage – community investments	2,320,000	11,600,000
Leverage – agricultural producers' investments*	420,000	2,100,000
Leverage – investment in decontamination of aquatic sites	n. a.[46]	*9,000,000*
Subtotal	*2,972,000*	*23,860,000*
Man-made capital		
Prevention of agricultural pollution – Consumer's surplus (willingness to pay) – three watersheds	22,150,000	110,750,000
Access to the Lachine Canal – use value	Not considered	Not considered
Access and outings – use value	1,700,000	8,500,000**
Subtotal	*23,850,000*	*119,250,000*

Direct effect	Annual benefit (CA$)	Benefit over 5 years (CA$)
Natural capital		
Sports fishery – use value	Not considered	Not considered
Waterfowl hunting – use value	Not considered	Not considered
Shoreline protection –speed reduction – replacement cost	n. a.	50,000,000
Community work to protect and clean up shorelines, replant, protect habitats and remove garbage – replacement cost and recycling value	18,700,000	93,500,000
Protection of 107,000 hectares – ecological value of the habitat (a function)	15,200,000	76,000,000
Wildlife protection – St. Ours fish ladder (recreational value)	232,000	1,160,000
Subtotal	*34,132,000*	*220,660,000*
Human and social capital		
Community participation in joint action – opportunity cost of volunteer work – joint action, conduct of projects, Ecowatch	653,400	3,267,000
Availability of information – opportunity cost of time spent	490,000	2,450,000
Subtotal	*1,143,400*	*5,717,000*
Grand total	*62,097,400*	*369,487,400*
Total without leverage	***59,125,400***	***345,627,000***

Note: Figures are rounded.

* Leverage may also relate to a regular program.

** Evaluated over five years.

Once the list of benefits is considered to be complete, their distribution in time needs to be evaluated, at least for the five years of the Plan.

The annualized results (Table 3) are very positive, as the benefits listed—conservatively estimated—always exceed the costs.

Table 3
Flow of costs and benefits related to Phase III of SLV 2000
($ millions)

Type of benefit or cost	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003
Annual direct benefits*	62.1	62.1	62.1	62.1	62.1
Direct benefits produced only once**	0	0	16.65	16.65	16.65
Subtotal of benefits	*62.1*	*62.1*	*78.75*	*78.75*	*78.75*
Cost of regular spending	38.9	41.7	63.6	52.0	28.2
Costs new money	5.7	6.9	6.3	5.7	5.2
Subtotal of costs	*44.6*	*48.6*	*69.9*	*57.7*	*33.4*
Annual B/C	*1.39*	*1.28*	*1.13*	*1.36*	*2.36*

Note: Figures are rounded, as is the B/C ratio.

* Linear progression of benefits is assumed throughout the Action Plan.

** The benefits of the speed reduction (M$50) are realized over three years, i.e. from 2000, the year the measure went into effect.

It is clear from Table 3 that when spending is at its peak the benefits-costs ratio declines and, when it is at its low point (5th year of the plan), the ratio is highest.

To obtain a more dynamic profile, one may also evaluate the distribution of annual benefits and costs cumulatively to see how the benefit-cost ratio varies over the particular Action Plan period being looked at (see Appendix 6).

4.2 Sensitivity analysis

The benefits described above ignore individuals' preference for immediate benefits rather than those to be realized in the future. To reflect this preference, the benefits and costs are discounted so that they are considered to occur at the same time (the year 1998 in our study). In other words, all

costs and benefits are evaluated in 1998 dollars.

The choice of the discount rate that is supposed to represent people's time preference is a controversial one, and becomes still more problematic in a context of global environmental change (Azar and Sterner, 1996). The effect of a high discount rate is to depreciate benefits that are remote in time, whereas a low rate has the opposite effect.

In the study of Phase II, the rate considered was 7.5%. In this study, we use a rate of 5% and do a sensitivity analysis (measurement of the variability of results with two adjacent rates, namely 2.5% and 7.5%). And, to take into account periods of high inflation, we also discount at 10%. In addition, we look at two periods, namely the actual Plan period (5 years) and 20 years.

Using the 5% rate, over the five years of the Plan, the discounted values of benefits and costs are $310 million and $221 million respectively (Table 4), for an average discounted benefit-cost ratio of 1.41. The following table summarizes the data under the other assumptions. In all cases, and even in a more conservative context (7.5% and 10% rates), the benefits outweigh the costs.

Assuming beneficial effects over 20 years—a minimum period in environmental studies —the B/C ratio varies from 5.11 (5% discount rate) to 5.52 (2.5% rate). The Action Plan's positive impact becomes clearly very large.

Table 4
Discounting of benefits and costs and sensitivity analysis

Discount rate	2.5%	5%	7.5%
5-year period			
Discounted benefits (M$)	333.77	310.12	288.72
Discounted costs (M$)	236.47	220.58	206.3
Discounted benefits/costs	1.41	1.41	1.40
20-year period			
Discounted benefits (M$)	1308.8	1127.5	983.9

Discount rate	10%
5-year period	
Discounted benefits (M$)	269.63
Discounted costs (M$)	193.39
Discounted benefits/costs	1.39
20-year period	
Discounted benefits (M$)	868.6

5. CONCLUSION: THE ST. LAWRENCE ENVIRONMENT AS A DRIVER OF SUSTAINABLE DEVELOPMENT

Implementation of Phase III of the St. Lawrence Action Plan gave us an opportunity to go beyond environmental issues and look at both economic and social concerns. The efforts made, in spite of the limited infusion of new resources, have had the effect of maintaining or increasing not just financial capital, but also social and human capital, natural capital and man-made capital.

The increase in financial capital is measured by ripple effects and by economic spin-offs measured in dollars. In addition to the input into GDP—some $218 million—each dollar of new money invested under SLV 2000 Phase III generated investment, on the part of the various participating departments, of around nine dollars. In addition, SLV 2000 supported and even boosted a number of regular programs.

The addition to social and human capital is driven, in particular, by community commitment, which takes the form of volunteer work; co-operation between the various governmental and local stakeholders, as in the case of the Navigation component and the monitoring of the state of the St. Lawrence; and an improvement in knowledge of the environment and human health.

The increase of natural capital is seen in the environmental improvements to the St. Lawrence and its shores, or in the reduction of damage in some cases, and in the fact that certain fish species' reproduction has been facilitated and strategic habitats protected.

As for the increase in man-made capital, it lies in the development of river access points, local enhancement work and more effective manure storage facilities.

These various benefits, despite the methodological and other constraints on the evaluation, are remarkable in that they affect all capital sources that contribute to a nation's wealth and so foster sustainable development.

The St. Lawrence, an integral part of the history of Canada and Quebec and their social and economic development, is still a pillar of strength in the effort to spread the environmental wealth more widely throughout the economy and among the people, a great part of whom live on the shores of the River and the Gulf (nearly 85% if we consider the watershed as a whole).

Therefore, the investment in Phase III of SLV 2000 is an effective and original way of accentuating the shift toward sustainable development and thereby meeting the growing concerns of a world that is seeking a balance between a healthy and productive environment, a happy and fairer society and a decent economy that will also be viable in the long term.

Even apart from the exercise of evaluating the results of the Action Plan economically, which showed a clear benefit from the standpoint of public spending, through its three phases SLV 2000 has helped improve the supply of financial resources and of material and natural capital even as it developed human and social capital. Our collective and individual ability to make decisions and take action was also enhanced,[47] which, in a broader sense, also fulfils the conditions for sustainable development.

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APPENDIX 1

Glossary

Consumer's surplus	The difference between the (individual) use value of a good to a consumer and what the consumer in fact must pay (e.g. the price of the good).
Direct effects	The impact of spending on the economic activities by which goods or services are produced (first set of effects).
Discounting	An operation to determine the value today—called present value—of a future sum, benefit, or liability, in the light of the individual's, or society's, requirement for profitability or time preference. By calculating the present value of a future sum, discounting makes it possible to compare flows that do not co-occur.
Ecological function of information	Contributes to people's mental health by providing a peaceful, pleasant, inspiring environment.
Ecological function of production	Raw materials (resources), genetic resources and energy available for human use.
Ecological function of regulation	Control of ecological processes, in particular through biological productivity, which may for example provide a degree of self-purification and water flow control.
Ecological function of support	Supply of suitable spaces and substrates for various human uses (agricultural and aquacultural activities, recreation, dwellings).
Existence value	The economic value imputed to a resource solely because of its existence in nature.
Financial capital	All those goods produced in an economy and whose value is determined by the market. By extension, the quantifiable ripple effect and economic spin-offs of a project or program.
GDP (gross domestic product)	The value of all goods and services produced within a country or territory's borders during a given time.
Human capital	All those abilities found in a society that help improve a community's productivity (level of education and knowledge, technical skills and various types of training). This form of capital is closely related to *social and institutional* capital, i.e. all those abilities found in the set of organizations and institutions through which human capital may be enhanced (social network, education system, etc.).

Importation	Procurement, by economic agents in one country, of merchandise manufactured in another.
Incidental taxation	Mandatory levies, legally instituted, that benefit particular Crown entities or local communities and serve an economic or social goal.
Indirect effects	Are associated with new spending made possible by companies' and individuals' earnings as a result of the first set of effects (*Bureau de la statistique du Québec*, 1995).
Man-made capital	All those means of production (machinery, infrastructure, etc.) by which the production of goods and services may be maintained or increased. This form of physical or material capital, though assessable in dollar terms, is distinct from financial capital in that it represents tangible goods rather than their value, which may fluctuate. This distinction is important, particularly when speaking of public goods.
Measurement by value transfer and meta-analysis	An evaluation approach aimed at transposing the specific value of a good, service or use as measured in a different place or time (e.g. elsewhere in Canada or the USA)[48] to approximate the relevant geographic and temporal context (e.g. the St. Lawrence, its shores and watershed in the 1998-2003 period). Meta-analysis is another specific means of evaluation that may be used to map values onto various other conditions and contexts and so make a less biased transposition that will be valid in a larger number of cases.
Measurement of contingent valuation in a notional market	An evaluation approach aimed at completely determining one or more use values or existence values specific to a given natural resource or environment. This evaluation, done through targeted surveys of willingness to pay or receive, simulates a real market in order to assign a price to an environmental good or service that by definition is not bought or sold in any market. In some cases (e.g. recreational values), this evaluation is the last stage in measuring direct user spending, to the extent that it is possible to determine the value individuals impute to the good or service in question over and above what they already spend to use it. It should be recalled that use expenses (values) are more readily identifiable in a real market.
Measurement of costs saved	An indirect technique for measuring benefits by ascertaining damage averted or the mitigation of certain costs incurred because of public action under the Action Plan. This measure is often useful for assessing damage averted from the standpoint of natural capital (e.g. environmental degradation averted) or social and human capital (e.g. medical expenses saved).

Measurement of leverage

A relatively widespread project evaluation approach whereby the proportion of external investment, or the sum of all contributions stimulated by public spending—whether financial, material, or in kind—is determined. The lever effect is a useful measure for evaluating financial economic benefits.

Measurement of opportunity cost

An evaluation approach whereby a value is assigned to an action on the basis of the solution chosen in preference thereto. This measure, although it may be applied at different scales (e.g. a project), is to be used only for certain specific actions (e.g. assignment of a value to hours of volunteer work on the basis of a wage rate schedule for an equivalent period).

Measurement of replacement cost

An evaluation approach based on the requisite investment to ensure partial (e.g. a given ecological function of a natural environment) or full replacement (e.g. site remediation) of an ecological good or service. This evaluation technique often uses an estimate based on remediation costs or the compensatory cost of obtaining artificially a service equivalent to that of a natural resource (e.g. natural purification of a wetland area vs use of an artificial treatment plant).

Natural capital

All those resources that help to support or improve a population's quality of life through the production of goods and services. This form of capital includes water, air, soil and biodiversity in all its aspects (genes, species, ecosystems).

New money

Sums specifically committed to Phase III of SLV 2000 by the federal and provincial governments.

Option value

The value imputed, implicitly or explicitly, to conservation of a resource or good for later use.

Use value

The value of a good in terms of its current use.

APPENDIX 2

Databases Used for the Socioeconomic Assessment

Much of the information used for the socioeconomic study under Phase III of the St. Lawrence Action Plan was taken from St. Lawrence Vision 2000 (SLV 2000) Management Tracking System (MTS) data. The following information gives a description of this database, its usefulness and its role in the study, as well as a brief explanation of the way indicators were developed throughout the program.

Management Tracking System (MTS)

In January 1999, a working group of about 15 persons was formed to develop the MTS. The system design was arrived at by consensus between the various SLV 2000 partners. An MTS was developed to track financial planning and the progress of results and indicators in Phase III of SLV 2000. The system is based on the structure of SLV 2000, whereby 37 results are distributed among seven joint action committees. It is accessible over the Internet to all members of the joint action committees, Agreement Management Committee (AMC) members, and members of the advisory committee. The AMC and the joint action committees agreed that two to three follow-ups of SLV 2000 results would be done each year to meet decision-making needs.

Since the MTS went on line, six follow-ups have been completed and reports have been produced on that basis. Once analysed by the Co-ordination Office, these reports were used by the AMC in its mid-plan review, by program evaluators, auditors from the Office of the Commissioner for the Environment and Sustainable Development, by the SLV 2000 Executive Committee and by the advisory committee.

Performance indicators

A performance framework was developed to help committees document their performance throughout the Action Plan. It is based on a series of performance indicators. The joint action committees identified 133 performance indicators, of which 106 were selected and integrated into the MTS to document Phase III results. So far the joint action committees have recorded 52 indicators at least once in the MTS. Each joint action committee has developed its own collection strategy; some indicators may be recorded once a year, but others only at the end of the program. A certain number of performance indicators were selected for purposes of this study. They have been classified according to the various types of capital: financial, man-made, natural, social and human.

APPENDIX 3

Persons Met or Contacted (Fall 2001 – Summer 2002)

France Delisle, co-ordinator, Agriculture component
Raymond-Marie Duchesne, co-ordinator, Agriculture component
Pierre Fortin, co-chair, Agriculture component
Denis Sanfaçon, co-chair, Agriculture component
Héloïse Bastien, co-ordinator, Biodiversity component (river access)
Hélène Bouchard, co-chair, Biodiversity component (state of the environment monitoring)
André Gendron, project officer, Biodiversity component
Renée Langevin, co-chair, Biodiversity component (Habitat subcommittee)
René Lesage, co-chair, Biodiversity component
Sylvain Paradis, project officer, Biodiversity component
Luc Robillard, project officer, Biodiversity component
Alain Bernier, co-ordinator, Industrial and Urban component
Jacinthe d'Amours, co-chair, Industrial and Urban component
Pierre Darcy, co-ordinator, Navigation component
Marc Demonceaux, co-chair, Navigation component
Jérôme Faivre, co-chair, Navigation component
Vincent Jarry, project officer, Navigation component
Chantal Ouellet, co-chair, Navigation component
Claude Mailloux, member, Navigation component
Thérèse Baribeau, project officer, Community Involvement component
Marc Hudon, co-chair, Community Involvement component
Jean-Yves Roy, co-chair, Community Involvement component
Guy Larochelle, project officer, Community Involvement component
Josée DeGuise, co-chair, Community Involvement component
Françoise Lapointe, SLV 2000 website editor, Communications component
Clément Dugas, co-chair, Communications component
Danielle Coulombe, co-ordinator, Communications component
Doug Haynes, project officer, Human Health component
Claire Laliberté, co-ordinator, Human Health component
François Boulanger, Canadian Environmental Assessment Agency
Yves Bourassa, Regulatory and Economic Analysis Directorate, Environment Canada
Christiane Hudon, St. Lawrence Centre, Environment Canada
Michel Villeneuve, Regulatory and Economic Analysis Directorate, Environment Canada
François Granger, Lachine Canal, Parks Canada

APPENDIX 4

Interview Guides—Gathering Data to Supplement the MTS

Since these were semi-directed interviews, interviewers were free to add questions of their own to those in the Interview Guides, which were merely starting points for the exchanges with resource persons met or contacted.

Guide No. 1 – Interview with Co-chairs

SLV Phase III component: _____

Objectives: To elicit Phase III highlights (identification) in terms of overall results and fill data gaps in the MTS. Another goal of the interviews was to validate the contribution of SLV money as opposed to amounts already granted under regular activities or programs.

Questions on the component

How long have you been co-chair of the committee? ____.

In your view, what are the SLV-related activities that are most significant for your component? *Significant because of their innovativeness, their major environmental effects, or the contributions of the private sector or NGOs, or because you succeeded in forming a variety of partnerships.*

Of these activities, are there some you are particularly proud of in terms of results or which you see as extraordinary? For what reasons (indicators, information sources)?

What has been the role of SLV financing in these cases, as opposed to regular programs? (decisive because of leverage, support was important but not essential, support was relatively marginal).

Validity of results

- Do you consider the results obtained short-, medium- or long-term gains? Why?
- Could the results obtained have been improved? If so, how?

Guide No. 2 – Interview with Co-ordinators

SLV Phase III component: _____

Objectives: To elicit data for use in quantifying Phase III highlights in terms of overall results may be quantified and to fill data gaps in the MTS. Another goal of the interviews was to validate the contribution of SLV money as opposed to amounts already granted under regular activities or programs.

Questions on the component

How long have you been co-ordinator of the committee? ____.

In your view, what are the SLV-related activities that are most significant for your component? Why? Do you have data other than that from the MTS to support your opinion? Could other stakeholders or project leaders give us further information on this?

What has been the role of SLV financing in this case? (initiating, supporting, marginal)? Why?

Could this role have been better defined in view of the new credits then available? For what reasons?

Validity of results

- Do you consider the results obtained short-, medium- or long-term gains? Why?
- Could the results obtained have been improved? If so, how?

Guide No. 3 – Interview with project leaders

SLV Phase III component: _____

Objectives: To elicit precise complementary data drawn from the various projects targeted as particularly important. Another goal of the interviews was to validate the contribution of SLV money as opposed to amounts already granted under regular activities or programs.

Questions specific to the project, activity or program

With respect to the (_____) project, how do you relate it to improvement in environmental conditions?

- Are there gains in terms of conservation of the water resource or of biodiversity? What are they? (identification)
- Of those gains, are there any of particular significance to this project? Which? (weighting)
- How do you explain these results? (justifications)
- Could the results have been more conclusive, higher? Why? (evaluation)

Were there improvements in terms of infrastructure, development of or access to the St. Lawrence or the Gulf?

- What were those improvements? (identification)
- Are some of them more important than the others? Which? (weighting)
- For what reasons? (justification)
- Are there any figures on projected visits as a result of these improvements? (evaluation)
- Are there any data on visitors' or users' spending? (evaluation)

In terms of knowledge acquisition, what gains can be identified?

- What additional knowledge have we thanks to SLV money? (identification)
- Was there any really new knowledge? What was it? (weighting)
- How is that important? (justification)
- Is there a potential for knowledge transfer to current or potential partners? (evaluation)
- Is that truly a feature of the SLV contribution? (evaluation)

In the field of technical and technological innovations, what gains can be identified? (identification)

- What is being better or more effectively done thanks to SLV money, and how is that important? (justification)
- Is there a potential for applied knowledge transfer to current or potential partners? (evaluation)
- Is this truly a feature of the SLV contribution? (evaluation) Without SLV money, what would have happened?

Is an improvement or a beginning of joint action among the recognized results of any of your actions?

- What was the role of this joint action? What were its effects? (identification)
- Were some effects more significant than others? (weighting)
- What role did SLV money play? (justification)
- Is this truly a feature of the SLV contribution (evaluation)? Without SLV money, what would have happened?

With respect to information dissemination, what were the gains?

- What audience was reached, and in what ways? (identification)
- What medium or event was significant? (weighting)
- Why? Was any particular effort or any new communications mode undertaken because of SLV money? (justification)
- Is this a feature of the SLV contribution? (weighting)
- Was any evaluation (even a rough one) done of the number of visitors, meetings, website visits, readers, etc.? (evaluation)

Did the project contribution take the form of external contributions?

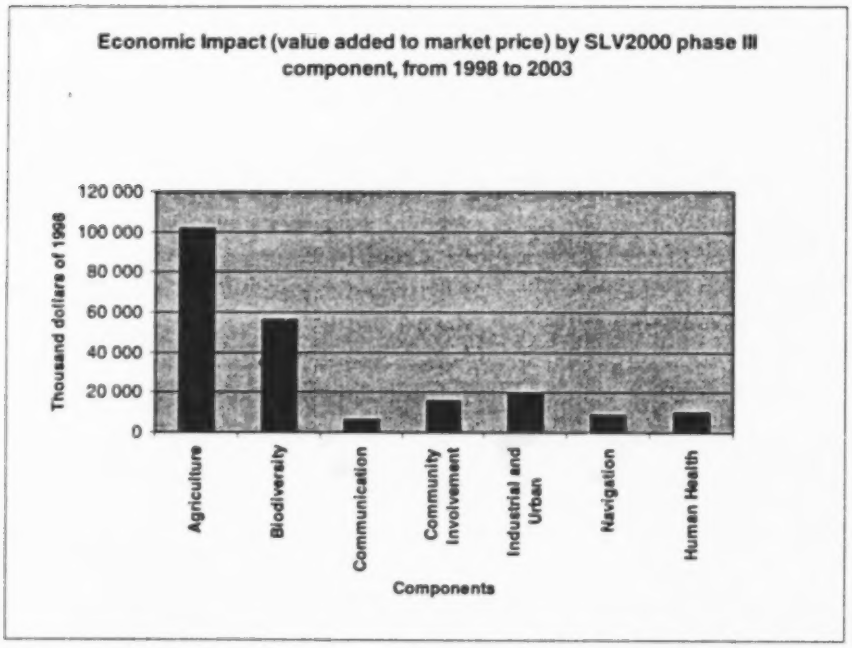
- Was there any financial contribution from the private sector? From the municipal or quasi-governmental sector? How much? (identification)
- Do you consider that a major or a minor contribution? (weighting)
- Were there other forms of contribution (time or volunteer work, equipment loaned or donated, various rental costs paid by others, etc.)? (identification)
- Do you consider that a major or a minor contribution? (weighting)
- Did SLV money enable you to maintain or step up your regular activities? [indispensable contribution, limited but necessary contribution, little or no effect] (evaluation)

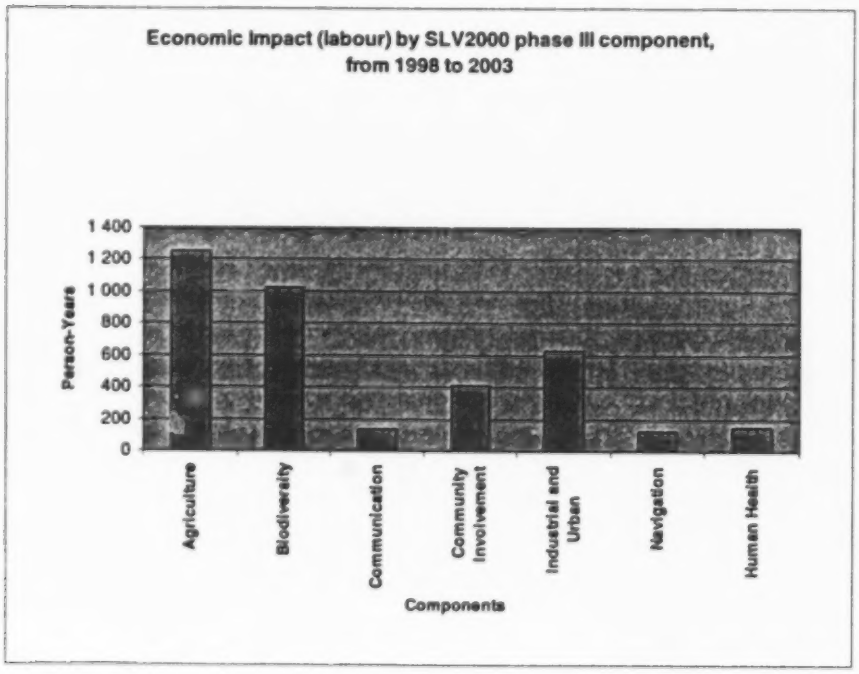
Validity of results

- Do you consider the results obtained short-, medium- or long-term gains? Why?
- Could the results obtained have been optimized? If so, how?

APPENDIX 5

Summary Data on Economic Spin-offs by Component





APPENDIX 6

Table of Cumulative Annual Benefits and Costs
($ millions)

Type of benefit or cost	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003
* Annual direct benefits	62.1	124.2	186.3	248.4	310.5
Direct benefits produced only once**	0	0	16.65	16.65	16.65
Subtotal of benefits	62.1	124.2	202.95	281.7	260.5
Cost of regular spending	38.9	80.6	144.2	196.2	224.4
Costs, new money	5.7	12.6	18.9	24.6	29.8
Subtotal of costs	44.6	93.2	173.1	220.8	254.2
Cumulative B/C - not updated	1.39	1.33	1.17	1.28	1.42

Note: Figures are rounded, as is the B/C ratio.

* Linear progression of benefits is assumed throughout the Action Plan.

** The benefits of the speed reduction (M$50) are realized over three years, i.e. from 2000, the year the measure went into effect.

ENDNOTES

1 French note not applicable in English.

2 As indicated in the introduction by G. Gauthier: G. Gauthier and M. Thibault (eds.), *L'analyse coûts-avantages, défis et controverses*, 1993, 526 p.

3 For example, by the late 1980s data already existed by which a fairly broad summary of these new tools could be given: R. C. Mitchell and R. T. Carson, *Using Surveys to Value Public Goods, the Contingent Valuation Method*, D.C., 1989, 463 p.

4 Evaluation of the "welfare" that results from government action is made more difficult by considerations of the environment as a public good, equity and diversity of opinion. See R. J. Kropp, A. J. Krupnick and M. Toman, *Cost-Benefit Analysis and Regulatory Reform: An Assessment of the Science and the Art*, Discussion Paper 97-19, 1997, 60 p.

5 In spite of the analysis given here, there are other ways of converting this information depending whether one form of capital or another is most valued. Theories about ecosystems and social systems may shed a different light on the notion of development and wealth of nations.

6 See general interview guides in Appendix 4.

7 A series of indicators are contained in the Management Tracking System (MTS) implemented at the beginning of Phase III and updated periodically.

8 Use values – with or without sampling, option and existence values are practically never fully evaluated. At best, some use values are well documented in addition to commercial values. Existence values are still less often evaluated.

9 There are a variety of books on evaluation methods: some are more general, like the one by D. W. Pearce and R. K. Turner, *Economics of Natural Resources and the Environment*, 1990, 378 p., and others more focused, like the one by R. C. Mitchell and R. T. Carson, *Using Surveys to Value Public Goods, the Contingent Valuation Method*, 1980, 463 p., wich is one of the indispensable historic references.

10 This is true, for instance, of measurement of the lever effect that is directly measurable from data collated in the MTS or data on estimated economic spin-offs furnished by the intersectoral model of the *Institut de la statistique du Québec*.

11 When considering the approach, the value transfer technique that will be used to evaluate certain advantages is at best approximate.

12 At the time of the Phase II study, the opportunity cost corresponded to "compound interest lost over a five-year period" and was based on the "average weighted rate of a long-term Canadian Treasury bill", equal at that time to about 5.6%.

13 Time preference (future losses and gains devalued vis-à-vis the present) has been the subject of much debate, particularly in the context of public projects. The underlying problem in the choice of discounting procedures, according to R. Sugden and A. Williams in *The Principles of Practical Cost-Benefit Analysis*, 1978, 269 p., is the difficulty of determining the right discount rate in accordance with a common social preference; hence the need to do a sensitivity analysis.

14 At the time of the Phase II study, two periods were selected: 5 years (duration of the Plan) and 20 years (measurable environmental impact) —10 years would no doubt also have been relevant —, and two rates, namely 5% and 7.5%, which were again used in Phase III to facilitate comparisons with the earlier data. To better respect the formal condition of intergenerational equity, we propose, in this study, to add a lower rate, namely 2.5%.

15 In Quebec, in 2001, the total population was 7,383,300, or 23.9% of the population of Canada (S. Langlois, "Les grandes tendances – aspects démographiques", in *Québec 2002: Annuaire politique, social, économique et culturel*, p. 101-118.

16 These effects are generally estimated by simulation using an input/ouput model representing the working of the economy. The simulation involves the use of multipliers to predict the possible effects of one economic sector's spending on another sector. In Quebec, the intersectoral model of the *Institut de la statistique du Québec* (ISQ) (formerly the *Bureau*) is recognized as the best tool for simulating these effects or impacts.

17 The ISQ (2002) acknowledges that its model has certain limits, in particular the fact that inputs are not substitutable, nor are economies of scale reflected, for the period of the simulation. There are no limits as regards the economy's production capacity; the economy is in an equilibrium state and the relationship between direct,

indirect and induced effects remains linear. We should add that the Action Plan's expenditure distribution is not detailed enough to ensure a completely faithful simulation of the economic sectors impacted.

18 These contributions are mainly from private companies, the EPA and of the International Joint Commission (IJC). See C. Lachapelle, *Compilation – Domaines d'intérêt, 5 ans*, table, 04-04-02, MTS. Note that the special IJC contribution to the NIVODO program (related to the Biodiversity component) will be still larger in 2002-2003.

19 MTS data also indicate that $4.34 million was provided by the Community Interaction program and that the total value of projects was therefore nearly $11.3 million in March 2001.

20 During Phase III, the ten ZIP committees in place began implementation of the ERAPs they had drawn up during Phase II in co-operation and partnership with the community and the other four new ZIP committees will have developed their ERAPs and conducted a number of projects related to them.

21 To assess this impact, the intersectoral model of the *Institut de la statistique du Québec* was used, all valuations being in 1998 dollars, as that was the year the Plan was announced. See *Institut de la statistique du Québec, Étude d'impact économique pour le Québec de Saint-Laurent Vision 2000 (SLV 2000 phase III) pour les années 1998 à 2003*, 2002, 29 p. and tables.

22 These revenues include the various taxes levied by governments as well as employers' contribution to the various plans, i.e. QPP, CSST, Employment Insurance etc.

23 In view of the numerous fluctuations that have occurred in recent years, we use the average monthly value of Treasury bills over one year during the March 1998 to March 2002 period (www.bank-banque-canada.ca/cgi-bin/femecgi_fdps). This rate of 4.8% is about midway between the lowest rate for the period (2.2% on December 31, 2001) and the highest rate (6.25% on May 31, 2000). The rate could be slightly different if it were possible to consider data up to March 31, 2003.

24 During Phase II there was a lot more new money, so that the opportunity cost too was much higher.

25 This project, which is intended to promote recreational boating, consists of the restoration and reactivation of locks and bridges, the stabilization of walls and the excavation of certain basins as well as the development of new structures. However, SLV 2000 does not deserve exclusive credit for this work, as it invested little new money. However, the Plan did firm up the partnership between Parks Canada and Canada Economic Development.

26 This figure is taken from the combination of three environmental reviews of these watersheds: 173,000 persons in 1996 according to M. Simoneau, L. Pelletier and N. Martel (1998). *Le bassin de la rivière Chaudière : profil géographique, sources de pollution et interventions d'assainissement*, Le bassin de la rivière Chaudière : l'état de l'écosystème aquatique, 1996, p.1-1 to 1.34; 375,000 persons in 1994 according to F. Delisle, S. Gariépy and Y. Bédard, *Bassin versant de la rivière L'Assomption : l'activité agricole et ses effets sur la qualité de l'eau*, 1997, 110 p.; 236,000 persons according to the Direction des écosystèmes aquatiques, *État de l'écosystème aquatique du bassin versant de la rivière Yamaska, synthèse 1998*, 12 p. A ratio of 4 persons per household has been used, even though this ratio was in fait lower in Quebec as a whole, i.e. around 3.6 in 1996, and was approaching 3.4 in 2000 (see P. Lefebvre, "L'impact réel des politiques natalistes", *Québec 2002 : Annuaire politique, social, économique et culture*, 2001, p. 137-147).

27 Depending where we look in the Montreal archipelago, the value is between $2.65 and $4.10 (1983) for a day's activity involving only picnicking. For cycling, by way of comparison, the values were $3.28 to $4.88 and, for fishing, of $2.73 to $4.18. Secrétariat Archipel, *Analyse de rentabilité du projet Archipel*, 1984.

28 Data taken from the 1996 *Survey on the Importance of Nature to Canadians*, Statistics Canada for Environment Canada. The data retrieval work was done in the winter of 2001 by Michel Villeneuve, Environmental Economics Branch, Environment Canada.

29 É. Dewailly, J. Grondin and S. Gingras, *Enquête santé sur les usages et perceptions du Saint-Laurent*, St. Lawrence Vision 2000, Government of Canada and Government of Quebec, 1999, 196 p. and appendices.

30 This estimate was supplied in 1997 by D. Lehoux, a specialist on shoreline erosion issues at the Canadian Wildlife Service. The figure was used in the Phase II study and has been retained to facilitate comparisons between the phases of the Action Plan.

31 Even though the hourly rate schedule has since gone up, this figure has been retained for purposes of comparison of the phases of the St. Lawrence Action Plan.

32 According to a study on the redevelopment of certain sites for the Quebec City ZIP committee (Dessau, 1997), the cost of stabilizing a 1-km strip 50 m in width can be estimated at $77,000. Considering that the work most

often requires shoreline modifications as much as 150 m inland, the probable cost may be as much as $231,000 per linear kilometre. The 378.3 km are therefore worth some $87.38 million.

[33] D. Clapin-Pépin's article, "Au moins 25 millions de dollars pour le suceur cuivré", *Le Naturaliste Canadien*, vol. 121, No. 1, 1997, gives a indication of the value of the suceur cuivré (copper redhorse) using an existence value simulation exercise carried out with a group of accounting students.

[34] The data used was provided by the project officer in March 2002 and relates to the years 1998-1999 to 2000-2001 (Ecowatch Network, T. Baribeau, 2002). Note that the average is conservative, as statistical data shows an increase. These figures are higher than those in the MTS.

[35] Opinions voiced in informal discussions with various component stakeholders (2001 and 2002). See the list of persons met or contacted (Appendix 3).

[36] Data taken from a February 2002 *Webtrends* report (<http://slv2000.qc.ec.gc.ca/stats>), revised and updated by F. Lapointe, *Historique sur les statistiques du site Internet de Saint-Laurent Vision 2000*, March 2002 and again updated following an interview in May 2002.

[37] This is an indication of the interest in keeping the information available on line. Based on a photocopy cost of 10 cents a page, the opportunity cost of acquisition of this information would be $230/day, or $80,500 for a year of 350 days.

[38] This is a measure of visitors' interest in remaining on site (reading on line), and so, indirectly, of their appreciation of the information on the site. Note that the more recent data attracts close to 500 sessions a day.

[39] The minimum wage used is $7/h, which is the official rate in Quebec. Note that in March 1998 the rate was $6.80 (Quebec department of labour 1998-1999 annual report). In October 2002 it rises to $7.20, then, in February 2003, $7.30/h, according to the a statement by the Minister of State for human resources (Workopolis.com, Thursday, May 2, 2002).

[40] This responds to a major concern expressed by the Commissioner of the Environment and Sustainable Development (Report of the Commissioner of the Environment and Sustainable Development to the House of Commons, 2001, *Great Lakes and St. Lawrence River Basin*, chapter 1, 361 p.) and by the SLV 2000, which brings together some thirty stakeholders from outside the Action Plan (SLV 2000 Advisory Committee's opinion on the mid-plan progress of SLV 2000, October 30, 2000, 22 p.).

[41] Essentially direct medical expenses. Supplementary expenses (e.g. travel to hospitals, loss of work days for parents who must go to the hospital, anxiety, etc.) are not accounted for. Neither are expenses to alleviate deficits included in this amount. See A. Cangelosi, R. Weiher, J. Taverna and P. Cicero (2001), *Revealing the Economic Value of Protecting the Great Lakes*, Northeast-Midwest Institute, National Oceanic and Atmospheric Administration, US Dept. of Commerce, Washington, DC, p. 179-181.

[42] A summary of the data on measurement of willingness to pay in the United States in the context of a cost/benefit assessment of public policies revealed that a human life of about 70 years may be worth US$4.8 million (1990) and that each additional year in good health may be worth US$120,000 (1990). The authors acknowledge, however, that there are large variations in these values from one federal agency to another. See R. H. Frank and C. R. Sunstein, *Cost Benefit Analysis and Relative Position*, AEI-Brookings Joint Center for Regulatory Studies, Research Paper No. 00-5, University of Chicago, 2000, J. M. Olin, *Law & Economics*, Working Paper no. 102, Social Science Network Paper Collection, May 2000, 36 p.

[43] The impact on the Magdalen Islands seems to have been particularly strong in 1998, as the media conveyed the information in a manner that aroused great concern in people throughout Quebec.

[44] The Walkerton case involved bacterial not chemical contamination. However, chemical contamination may cause serious health problems depending on the dose. In addition, Walkerton was a small municipality. Along the St. Lawrence, a large proportion of the municipalities are bigger than Walkerton; the water intake for Montreal, no doubt the biggest, supplies close to two million people.

[45] These effects are reported in chapitre 2 of the following document: D. R. O'Connor, *Report of the Walkerton Inquiry: The Events of May 2000 and Related Issues*, Part I, A Summary, Queen's Printer for Ontario, 2002, p. 41-53. Two vectors were identified as the cause of this tragedy: *Escherichia coli* (var. O 157:H7) and *Campylobacter jejuni*.

[46] n.a. = not applicable

[47] The Nobel Prize winner for economics Amartya Sen, in a summarizing work, *Development as Freedom*, New York, Anchor Books, Random House Inc., 1999, emphasizes the importance of simultaneously developing the preconditions for development and looking ahead to opportunities of one's own choosing.

[48] Economic valuation studies that can serve as a baseline are legion in the United States and in Europe, but rarer in Canada.